99th Congress, 1st Session - - - - - - - - - - - House Document 99-135

MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS)

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

TRANSMITTING

A REPORT AND SUPPLEMENTAL REPORT OF THE CHIEF OF ENGINEERS ON MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS). THESE REPORTS ARE IN RESPONSE TO THE PRESIDENT'S MEMORANDUM TO THE SECRETARY OF DEFENSE, DATED MAY 18, 1982, AND CONDUCTED UNDER THE AUTHORITY OF SECTION 216 OF THE FLOOD CONTROL ACT OF 1970

DECEMBER 10, 1985.—Referred to the Committee on Public Works and Transportation and ordered to be printed with illustrations

99th Congress, 1st Session - - - - - - - - - - - - House Document 99-135

MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS)

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A REPORT AND SUPPLEMENTAL REPORT OF THE CHIEF OF ENGINEERS ON MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS). THESE REPORTS ARE IN RESPONSE TO THE PRESIDENT'S MEMORANDUM TO THE SECRETARY OF DEFENSE, DATED MAY 18, 1982, AND CONDUCTED UNDER THE AUTHORITY OF SECTION 216 OF THE FLOOD CONTROL ACT OF 1970.

DECEMBER 10, 1985.—Referred to the Committee on Public Works and Transportation and ordered to be printed with illustrations

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U.S. GOVERNMENT PRINTING OFFICE

55-487 O WASHINGTON : 1985

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EXHIBIT

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

26 NOV 1985

Honorable Thomas P. O'Neill, Jr.
Speaker of the House of Representatives
Washington, D. C. 20515

Dear Mr. Speaker:

I am transmitting herewith a report dated April 3, 1985, a supplement dated May 7, 1985, and a memorandum dated October 11, 1985, enclosing a Decision Document, from the Chief of Engineers, Department of the Army, on Mount St. Helens Sediment Control, Washington (Toutle, Cowlitz, and Columbia Rivers), together with other pertinent reports. These reports were prepared under the authority of Section 216 of the Flood Control Act of 1970.

The views of the Governors of Washington and Oregon; the State of Idaho; the Departments of the Interior, Agriculture, Transportation, and Health and Human Services; the Environmental Protection Agency; and the Federal Emergency Management Agency are set forth in the enclosed communications, together with pertinent replies.

The recommendation of the Chief of Engineers in his April 3, 1985, report and in his October 11, 1985, memorandum was to implement a single stage Sediment Retention Structure with a 125 foot high spillway, together with a levee modification at Kelso and dredging work. This plan was authorized for construction by Public Law 99-88, the Supplemental Appropriation Act, 1985. We believe that the plan and the local cooperation requirements authorized in this Act are appropriate.

The Office of Mangement and Budget concurs in the above recommendation and has no objection to the submission of this report to the Congress. A copy of its letter is enclosed.

Sincerely,

Robert K. Dawson
Acting Assistant Secretary of the Army
(Civil Works)

Enclosures

COMMENTS OF THE GOVERNOR OF WASHINGTON

STATE OF WASHINGTON
OFFICE OF THE GOVERNOR

OLYMPIA
98504-0413

BOOTH GARDNER
GOVERNOR

March 1, 1985

Lieutenant General E. R. Heiberg III
Chief of Engineers
ATTN: DAEN-CWP
Department of the Army
Washington D.C. 20134-1000

Dear General Heiberg:

We appreciate the opportunity to review your proposed report to the Secretary of the Army on the Mount St. Helens Sediment Control Project. The state task force on Mount St. Helens has reviewed this report, along with the final environmental impact statement, and has given me its recommendations.

The catastrophic eruption of Mount St. Helens in 1980 was perhaps the most unique disaster to occur in the United States in recorded history. Solving the problem will mitigate the threat to life and property in Washington State and the possibility of impeding shipping commerce on the Columbia River. Therefore, widespread benefits will be derived by the entire northwest and intermountain states. It would be patently unjust and incorrect to categorize the Mount St. Helens stream sediment problem and corrective measures with so called "flood control" or "water resource development" projects.

The state of Washington supports this project and agrees with the preferred plan consisting of a single retention structure on the Toutle River, with associated downstream actions. Legislation has been introduced in the current session of the state legislature to appropriate $12.9 million for the major portion of the recommended cost share formula. Cowlitz County has committed $4 million toward the proposed amount of $16.9 million.

We commend the Corps for its commitment in timing the construction activity to minimize fishery problems and in providing an environmental task force for monitoring construction impacts and in developing appropriate mitigation for project related impacts. We also appreciate the inclusion of our recommended mitigation for loss of fish facilities (because of the project) as outlined in the Final Feasibility Report. Certain cost share and mitigation proposals also must be considered unique and do not set precedents for future federal projects in Washington State.

Finally, our interpretation as to the recommendation of non-federal responsibility set forth in the Final Feasibility Report on page X-10, paragraph a. as it relates to the issue of costs for relocation of SR 504 outlined on page X-6, last paragraph, is as follows:

(1) to perform all actions as stated with regards to acquisition and conveyance of lands; and,

(2) assume all costs associated with alteration and reallocation of all items listed over and above the $4,300,000 extraordinary cost associated with readjustment to Highway 504.

I appreciate the opportunities we have had to participate with the Corps in the formulation and evaluation of this project.

Sincerely,

Booth Gardner
Governor

cc: Congressional Delegation

LETTER TO THE GOVERNOR OF WASHINGTON

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO ATTENTION OF:
Planning Division

April 3, 1985

Honorable Booth Gardner
Governor of Washington
Olympia, Washington 98804-0413

Dear Governor Gardner:

Thank you for the comments contained in your March 1, 1985, letter regarding the Mount St. Helens Sediment Control Project. The State's views and support are essential for project implementation.

In reference to fish and wildlife issues and as described in our response to the U.S. Fish and Wildlife Service's Coordination Act Report, we are closely coordinating project construction with Federal and State resource agencies. The cost sharing proposal for mitigation is unique to this project, and we appreciate the State's acceptance of the recommended cost sharing to provide necessary mitigation.

With regard to the relocation of State Route 504, the intent of paragraph a on page X-10 of the Feasibility Report is that all costs of highway relocations are a non-Federal responsibility. During the Continuation of Planning and Engineering Studies, if there is a public need for the highway, as discussed on page X-6, the relocation costs currently estimated at $4.3 million would become a project cost. However, it would remain a non-Federal responsibility as are other relocations should the project be authorized in accordance with the recommendations contained in my report.

Thank you for your continued support.

Sincerely,

E. R. Heiberg III
Lieutenant General, U. S. Army
Chief of Engineers

COMMENTS OF THE GOVERNOR OF OREGON

VICTOR ATIYEH
GOVERNOR

OFFICE OF THE GOVERNOR
STATE CAPITOL
SALEM, OREGON 97310

March 15, 1985

Lieutenant General E.R. Herberg III
Chief of Engineers
Attn: DAEN-CWP
Department of the Army
Washington, D.C. 20314-1000

ATTN: Colonel Paul W. Taylor

We have reviewed the proposed report of the Chief of Engineers for the Mt. St. Helens Sediment Control Project along with the Feasibility Report and Final Environmental Impact Statement. We generally concur with the preferred options.

The project to construct a sediment-retention structure would help protect the natural resources of the lower Columbia Basin and reduce requirements for dredging in the lower river channel and problems associated with disposal of dredged material. Additionally, it appears the project would protect the stream system from the problems of continued instream transport and deposition of highly erodible volcanic sediments.

We further recommend that future dredging and abatement programs necessary for sediment control continue to be reviewed through normal Corps of Engineers procedures to insure public and agency evaluation.

Sincerely,

Victor Atiyeh
Governor

VA:jt

COMMENTS OF THE STATE OF IDAHO

State of Idaho
DEPARTMENT OF WATER RESOURCES
STATE OFFICE, 450 W. State Street, Boise, Idaho

JOHN V. EVANS

A. KENNETH DUNN

Mailing address:
Statehouse
Boise, Idaho 83720
(208) 334-4440

February 25, 1985

Colonel Paul W. Taylor
Executive Director
Engineer Staff
Office of the Chief of Engineers
Army Corps of Engineers
Washington, D.C. 20314-1000

Dear Colonel Taylor:

Thank you for the the opportunity to comment on the sediment control of the Mount St. Helens eruption. This natural event did disrupt the northwest, and repair of such a natural event will be very expensive.

Our interest in the Mount St. Helens Sediment Control Project would be the protection of anadromous fish passage, and shipping in the Columbia River. The proposed alternatives are on the Cowlitz River, tributary to the Columbia River. We believe there will be little impact on the State of Idaho; therefore, we have no comments.

Sincerely,

A. Kenneth Dunn
Director

AKD:cjk

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 85/146 March 5, 1985

Lieutenant General E. R. Heiberg, III
Chief of Engineers
ATTN: DAEN-CWP
Department of the Army
Washington, D.C. 20314

Dear General Heiberg:

The Department of the Interior has completed its review of your proposed report, other pertinent reports, and final environmental statement on Mt. St. Helens Sediment Control, Washington. We have the following comments and recommendations.

Chief of Engineers' Report

General

The preferred plan may reduce, but it does not eliminate, the need for project features designed to mitigate adverse project impacts. The Department recommends that your report to Congress stress that mitigation measures will be incorporated in authorized plans, and that project impacts be monitored to ensure the success and adequacy of these measures. The major fish and wildlife features we recommend are: (1) construction of instream habitat improvement measures at project cost in areas below the proposed structure; (2) construction of fish passage facilities; and (3) prioritization of dredged material disposal area use and subsequent management of selected areas to mitigate for anticipated wildlife losses.

The Department maintains that, while it may be appropriate for local sponsors to share the cost of project mitigation, the Corps must recognize that it is their full responsibility to ensure that project construction and mitigation are accomplished in accordance with Federal environmental policy and legislation. This requires the recognition of project impacts, reducing impacts through selection of least damaging alternatives where possible, mitigating for remaining impacts, and monitoring of project and mitigation actions to ensure they function as planned.

The Department is further concerned that the proposed formula for cost sharing—namely that operation and maintenance (O&M) expenses for mitigation features be totally funded by non-Federal interests—may not accomplish the mitigation objective. Specifically, if the State fish and game departments are required to operate and maintain mitigation features without additional State or Federal funding, those agencies would have to

reduce resource management actions elsewhere to accomplish this new work. Therefore, the Corps should fund the O&M costs of mitigation measures, or ensure that the cost-share formula does not place this burden on the State fish and game departments.

Fish and Wildlife Mitigation

The Department is concerned about the lack of reference in your proposed report to the need for mitigation downstream of the single retention structure. The Coordination Act Report (CAR) prepared by our Fish and Wildlife Service (FWS) recommended specific stream habitat improvement actions for fish in the Green and South Toutle Rivers. These items were recommended as mitigation for the loss of 17 river miles of habitat due to project caused sediment inundation upstream of the proposed Green River Dam.

These mitigative actions are acknowledged as valid in the Corps' response to the CAR recommendations in Exhibit I of the feasibility report, but are not referred to in your proposed report. In fact, in item 15 e of the Board's Report, it is stated that no mitigation other than fish passage facilities is found to be justified. We strongly recommend, in addition to the fish passage facilities that the Corps has accepted as mitigation, that the stream habitat improvement actions also be included in the formal feasibility report forwarded to Congress for authorization.

In responding to recommendation of the CAR, the Corps has stated its willingness to discuss mitigation needs for dredging and dredged material disposal as part of its maintenance of the Columbia River Navigation Channel. The feasibility report and environmental impact statement (EIS) identify the need to continue dredging operations at the mouth of the Cowlitz River in conjunction with the project, yet this action would be carried out under existing authority to maintain the channel.

To avoid the question of segmentation under the National Environmental Policy Act, and show a continued willingness to improve this study effort, your proposed report should make a positive statement that justifiable mitigation would be implemented, regardless of which authority is used for project implementation. It was at the request of the Corps that the FWS evaluated the impacts of downstream dredging on fish and wildlife as an overall part of the project. Mitigation needs for this part of the project have been identified and reported accordingly.

Monitoring

It is our understanding that construction activities will be monitored in an effort to reduce or eliminate adverse project impacts to fish and wildlife resources. We agree that project monitoring efforts should not be directed at analyzing the impacts of the eruption on fish and wildlife. However, we firmly believe that monitoring is needed to evaluate the overall impacts of a completed and operational project on the recovery and/or degradation of habitats upstream and downstream of the proposed dam.

The Corps has included a 25-year monitoring program to evaluate sediment movement, turbidity, and other related parameters following completion of the dam. This program should be expanded to monitor the dam's impact on the recovery of fish and wildlife. The Corps' monitoring program has been justified on the basis of the unique and unprecedented nature of the problem and the potential solution. Because of many general assumptions that must be made regarding unknown future weather events and sediment

transport under post project conditions, monitoring is required to keep track of actual conditions as they develop. This same logic also applies to how fish and wildlife resources will respond to construction activities, mitigative measures, and post project conditions.

Final Environmental Statement

The EIS provides some general analysis of impacts of the preferred alternative on fish and wildlife resources; however, the necessity to mitigate for adverse impacts is not clearly stated. Mitigation for certain impacts is included in the EIS only by reference to the CAR. We continue to emphasize the need to specify these mitigative actions in the text of the EIS as well as the feasibility report to better inform the reader of their necessity. It is also necessary to clearly express the extent of the Corps' commitment to carry out the recommended mitigation measures.

We hope these comments will be of assistance.

Sincerely,

Tom [signature]

for Bruce Blanchard, Director
Environmental Project Review

LETTER TO THE DEPARTMENT OF THE INTERIOR

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO ATTENTION OF:
Planning Division

April 3, 1985

Mr. Bruce Blanchard, Director
Environmental Project Review
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Blanchard: Bruce

Thank you for your letter of March 5, 1985, commenting on our Mount St. Helens, Washington, Feasibility Report and Final Environmental Impact Statement.

I understand your concern regarding the scope of mitigation actions associated with the Single Retention Structure on the North Fork Toutle River. As outlined in the feasibility report, the Corps of Engineers will continue to investigate appropriate mitigation measures for this project during Continuation of Planning and Engineering studies, which are expected to be completed this Fall. As part of this effort, we are coordinating our planning with the various state and Federal fish and wildlife agencies. Any mitigation measures found to be needed and economically justified will be included in the final plan.

I also understand your reluctance to support state operation and maintenance of mitigation features associated with a long-term solution to Mount St. Helens sediment problems. However, we believe that the proposed cost sharing plan equitably allocates responsibilities and costs between Federal participation and the beneficiaries.

Regarding your comments on mitigation for dredge material disposal associated with the Columbia River navigation project dredging at the mouth of Cowlitz River, the Portland District has initiated the formation of a multi-agency environmental task force to address the subject. Specifically, the task force will identify sites suitable for disposal and sites which might require mitigation as part of development of an overall dredging plan.

You also suggested that a monitoring program is needed to evaluate the overall impacts of a completed project. We intend to accomplish reasonable monitoring of implemented mitigation features to assess their effectiveness.

Your continued interest is appreciated.

Sincerely,

E. R. Heiberg III
Lieutenant General, U. S. Army
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

March 28, 1985

Lieutenant General E. R. Heiberg III
Chief of Engineers
Office of the Chief of Engineers
Army Corps of Engineers
U.S. Department of the Army
Washington, D.C. 20314

Dear General Heiberg:

We appreciate the opportunity to review the reports on Mount St. Helens, Sediment Control, Washington, and the draft bill to authorize implementation of a volcanic sediment management project.

The devastated watershed and the potential for further loss of life and property created an urgent need for an integrated basin-wide watershed recovery and management plan. A plan was developed by a task force of a number of federal, state, local, and private representatives--an outstanding example of interagency, multilevel government-private cooperation. The Cowlitz County Board of Commissioners adopted the Toutle-Cowlitz Watershed Management Plan on January 31, 1983. The U.S. Army Corps of Engineers (COE) helped develop and used information regarding sediment volumes and Strategy D (a large retaining structure) from the management plan. We believe that the Board should have acknowledged the management plan in the Background, Comprehensive Study (3C) section of its report. Such acknowledgement would broaden support for the proposal.

The proposed report and draft bill recommends a sediment control project for flood damage and navigation maintenance reduction of the Toutle, Cowlitz, and Columbia Rivers that is in accordance with the locally developed management plan. The recommended project is not in conflict with emergency measures and watershed treatment installed with the aid of this Department, nor in conflict with our policies or programs. We have no objection to the recommended project.

Sincerely,

John R. Block

John R. Block
Secretary

COMMENTS OF THE DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation
United States Coast Guard

Commandant
United States Coast Guard

Washington, DC 20593
Staff Symbol: G-WP-1
Phone: (202) 426-9584

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March 27, 1985

Lieutenant General E. R. Heiberg, III
Chief of Engineers
Attn: DAEN-CWP
Department of the Army
Washington, D. C. 20314-1000

Dear General Heiberg:

The concerned operating administrations of the Department of Transportation have reviewed the proposed reports and Final Environmental Impact Statement of the Chief of Engineers on the Mount St. Helens, Washington, Sediment Control. We have no comments to offer.

The opportunity to review the Mount St. Helens Reports is appreciated.

Sincerely,

J. G. Schmidtman

J. G. SCHMIDTMAN
Captain, U.S. Coast Guard
Chief, Planning and Evaluation Staff
By direction of the Commandant

COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X

1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

February 25, 1985

REPLY TO
ATTN OF: M/S 423

Lieutenant General E.R. Heiberg III
Chief of Engineers
ATTN: DAEN-CWP
Department of the Army
Washington, D.C. 20314-1000

RE: Mount St. Helens, Washington: Feasibility Report and Final Environmental Impact Statement

Dear General Heiberg:

We have reviewed the referenced document and proposed authorizing legislation to implement a management project for flood control and navigation on the Toutle, Cowlitz and Columbia Rivers.

We were generally pleased with the Corps' responses to our comments. The Portland District Corps of Engineers has agreed to the formation of a task force to address the issue of long-range dredged material disposal options near the mouth of the Cowlitz River. This agreement is a first step in providing an environmentally sound plan for handling dredged spoils in this area. We will have a member on that task force and will provide specific dredged material disposal option recommendations to the Portland District in the near future.

We were equally pleased with the Corps' commitment to undertake alternative mitigation measures if the fish passage plan proves to be unworkable. Acceptable alternative mitigation projects should be identified as soon as possible to assure that sufficient funding will be authorized to accommodate this need.

Based upon the information contained in the EIS and support documents, we support the Corps' decision to obtain authorization for any one of three management projects; a single retention structure, a phased single retention structure, or a dredging only alternative. This is consistent with our recommendation that the Corps use continually updated sediment data to evaluate alternative control strategies.

We are disappointed with the Corps' decision not to include dredged material disposal options and mitigation as a part of this project. We consider maintenance of the navigation channel at the mouth of the Cowlitz River to be an integral part of the Mount St. Helens problem and feel it should have been addressed in the EIS. We are concerned that funding for mitigation for wetland fills along the Columbia River that are a direct result of the excessive sedimentation caused by the eruption may not be

forthcoming unless included as a Congressionally authorized part of this project. If this authority cannot be used, we recommend that assessment of impacts to wetlands and mitigation be accomplished under the Corps' annual maintenance dredging authorization for the Columbia and Cowlitz Rivers. In this regard, we support the Corps' decision to effect this outcome (No. 23, response to EPA comments).

The water quality impacts section was substantially improved. However, we continue to have concerns about potentially degraded Stilling Basin water quality. We recommend a flushing plan be devised, in consultation with EPA and the Washington Department of Ecology, to eliminate the potential for adverse water quality in the Stilling Basin.

We appreciate the inclusion of the recommended additional information in the Final EIS. We continue to believe the document could have been substantially improved as a decision-making tool by the inclusion of the additional environmental impact information recommended in our comment letter on the Draft EIS (December 13, 1984).

If you have any questions concerning our comments, please contact me or Mr. Gary Voerman of my staff at FTS 399-1448.

Sincerely,

Ernesta B. Barnes
Regional Administrator

cc: USFWS-Portland
USFWS-Olympia
NMFS
WDE
WDG
WDF
COE-Seattle

LETTER TO THE ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:
Planning Division

April 3, 1985

Ms. Ernesta B. Barnes
Regional Administrator
U.S. Environmental Protection Agency,
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Dear Ms. Barnes:

Thank you for your letter dated February 25, 1985, commenting on our Mount St. Helens, Washington, Feasibility Report and Final Environmental Impact Statement.

In regard to your concerns about disposal of dredged material at the mouth of the Cowlitz River, we recognize the relationship between the project proposed in the Feasibility Report and the need to dredge sediment from the mouth of the Cowlitz. However, the purpose of sediment removal at the Cowlitz River mouth is to prevent material from entering the Columbia River navigation channel, thereby helping to maintain authorized channel depths. Public Law 87-874 provides the authority for maintenance of the Columbia River navigation channel, and the dredging at Cowlitz River mouth, therefore, will be accomplished under that authority. We are committed to the development of a plan which will identify sites suitable for disposal and sites possibly requiring mitigation for this dredging. Portland District has initiated the formation of an environmental task force, with EPA as a member, to develop this plan.

Evaluation of water quality effects of the project, including stilling basin water quality, is proceeding in the Continuation of Planning and Engineering stage of this study. Plans for regulation of flows through the retention structure are being developed at this time, taking into consideration factors such as sediment deposition, temperature changes, and other water quality effects. These evaluations will be coordinated with Federal, state, and local agencies concerned with water quality problems.

Thank you for your comments.

Sincerely,

E. R. Heiberg III
Lieutenant General, U. S. Army
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF HEALTH AND HUMAN SERVICES

DEPARTMENT OF HEALTH & HUMAN SERVICES — Public Health Service

Centers for Disease Control
Atlanta GA 30333

February 19, 1985

Colonel Paul W. Taylor
Executive Director, Engineer Staff
Office of the Chief of Engineers
Attn: DAEN-CWP
Department of the Army
Washington, D.C. 20314-1000

Dear Colonel Taylor:

Thank you for sending us a copy of the Final Environmental Impact Statement (EIS) on the Mount St. Helen's Sediment Control Project in Washington. We have reviewed your responses to our December 14, 1984, comments on the Draft EIS and find that our comments have been adequately addressed.

We understand that a sediment retention structure located on the North Fork Toutle upstream of the Green River confluence has been selected as the preferred alternative in the Final EIS. To allow sufficient flexibility in project authorization, the selection of another alternative, such as a staged single retention structure or dredging, may be warranted if supported by future studies.

While the alternative of limited permanent evacuation has been dropped from further consideration as a principal action plan, we believe the Department of the Army should encourage local communities to adopt and implement non-structural flood protection measures (i.e., flood plain ordinances, land use and building code regulations, relocation assistance for residents in highly flood prone areas, flood warning systems, and emergency flood evacuation programs) in concert with the selection of any structural plans.

We appreciate your concurrence to provide prior notification to any downstream surface water supplies and the opportunity to review the Final EIS.

Sincerely yours,

Stephen Margolis

Stephen Margolis, Ph.D.
Chief, Environmental Affairs Group
Center for Environmental Health

COMMENTS OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY

Federal Emergency Management Agency

Washington, D.C. 20472

March 15, 1985

Lieutenant General E.R. Heiberg, III
Chief of Engineers
Attention: DAEN-CWP
Department of the Army
Washington, DC 20314-1000

Dear General Heiberg:

The Federal Emergency Management Agency (FEMA) has reviewed your report, "Mount St. Helens, Washington Feasibility Report and Environmental Impact Statement" dated December 1984. The following comments are provided in response to your letter of January 11, 1985, to FEMA Director Louis O. Giuffrida.

As you are aware, FEMA, by virtue of its disaster recovery and flood insurance responsibilities, is vitally interested in the development of effective permanent solutions to the threats of future flooding and mudflows on the Cowlitz and Toutle Rivers. A significant portion of your $4.5 million estimate of annual flood damages that would be avoided along the Cowlitz River with construction of the preferred alternative (the Single Retaining Structure - SRS) are costs that would potentially require reimbursement by FEMA through the National Flood Insurance Program and the Disaster Assistance Program. At present, there are $460,098,400 worth of flood insurance policies in force in Cowlitz County, Washington. Furthermore, FEMA's disaster relief costs following the initial eruption of Mount St. Helens amounted to more than $38,000,000. We agree strongly, therefore, with Paragraph 13 of the Board of Engineers for Rivers and Harbors Summary which states in part "the threat to life and property and the continuing high cost of emergency measures require expedited authorization and implementation of a plan." By any measure, the residents of Cowlitz County and surrounding areas, and the taxpayers of the nation as a whole, have been fortunate that the largest storm in the Cowlitz-Toutle Valley since Mount St. Helens erupted in May 1980, has only been a 10-year event. Indeed, rainfall in December, 1984, was just over half the average for that month, and January 1985, rainfall was six inches below normal, setting a new all-time record low. The absence of recent storm activity belies the fact that an emergency situation still exists in this area, and the proposed actions, unlike projects designed to enhance flood control and navigation, are the minimum required to bring this area back to pre-eruption conditions.

In general, FEMA supports the National Economic Development (NED) preferred plan involving the construction of a Single Retaining Structure (SRS) on the Toutle River and continued navigational dredging on the Cowlitz and Columbia Rivers. As the Feasibility Report also notes, however, the uncertainty involved in predicting sediment transport calls for continued monitoring of sediment transport to review and evalute the planning and design assumptions. There should be flexibility to incorporate any improved estimates of annual or long term sediment yields into the design process. Both the reporting engineer and the Board of Engineers for Rivers and Harbors have recommended, and the proposed authorization legislation provides for flexibility for the Secretary of the Army to select a staged sediment retention structure or a dredging alternative if compelling evidence for these approaches is developed through continuing monitoring of sedimentation and further analysis of costs and benefits. While the dredging alternative could, therefore, be eventually chosen over the SRS, no dredging alternative is addressed in the environmental assessment. Before a decision would be made to select such an alternative, its impact should be investigated, especially in terms of its ability to deal with back-to-back flood events, which are not uncommon in this area, local drainage impacts of deposition of dredged material (this has already aggravated some local flooding problems) and adverse impacts on wetlands, which provide flood storage in addition to wildlife habitat. These impacts could potentially result in increased flood insurance and disaster assistance costs to FEMA, and therefore they should be considered carefully before the dredging option is chosen.

We are very grateful for the opportunity to review the Mount St. Helens Feasibility Report and hope the preceeding comments will be helpful. If there is any further clarification or background on FEMA programs required, please do not hesitate to let me know.

Sincerely,

Samuel W. Speck
Associate Director
State and Local Programs
and Support

MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS)

SUPPLEMENTAL REPORT OF THE CHIEF OF ENGINEERS

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO ATTENTION OF:

DAEN-CWP-A May 7, 1985

SUBJECT: Mount St. Helens Sediment Control, Washington (Toutle, Cowlitz, and Columbia Rivers)

THE SECRETARY OF THE ARMY

This supplements my report of April 3, 1985. Attached is proposed legislation which would implement my recommendation.

E. R. HEIBERG III
Lieutenant General, USA
Chief of Engineers

Enclosure

DRAFT

A B I L L

To authorize implementation of a volcanic sediment management project for flood control and navigation on the Toutle, Cowlitz, and Columbia rivers, Washington, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Army, acting through the Chief of Engineers, is authorized to design, construct, operate and maintain a Federal project for reduction of both flood damage and navigation maintenance on the Toutle, Cowlitz and Columbia rivers, Washington. Specifically, the Secretary of the Army, acting through the Chief of Engineers is authorized to construct a single stage sediment retention structure near the confluence of the Toutle and Green rivers with such design features as the Chief of Engineers determines to be advisable, including justified measures to mitigate for adverse environmental impacts associated with the project; except that, based on the results of continuation of planning and engineering studies, the Secretary of the Army may select and implement a staged sediment retention structure at the confluence of the Toutle and Green rivers or dredging alternative on the Toutle, Cowlitz, and Columbia rivers if he determines that continuing monitoring of sedimentation and further analysis of benefits and costs provide compelling and convincing new evidence to justify selection of a staged retention structure or dredging alternative.

DRAFT

Sec. 2(a). Prior to initiation of measures authorized by this section, non-Federal interests shall agree to:

(1) convey or otherwise provide to the United States, all lands, easements, and rights-of-way which the Chief of Engineers determines to be necessary for project construction and maintenance, including borrow sites for the removal of material needed for retaining works and disposal sites for the disposal of excavated material;

(2) accomplish any alteration or relocation of buildings, roads, bridges, or other structures or utilities which the Chief of Engineers determines to be necessary in connection with implementation of the project;

(3) in the event local interests are unable to comply with requirements (1) or (2) above in a timely manner, provide a cash contribution to the United States, at such times and in such amounts as the Chief of Engineers determines to be necessary to allow acquisition of the property by the United States in accordance with project construction schedules;

(4) hold and save the United States free from damage due to design, construction, operation, and maintenance of the project except damages due to the fault or negligence of the United States or its contractors;

(5) operate and maintain any federally undertaken mitigation project which the Chief of Engineers determines to be justified; and,

(6) maintain all dredged material disposal sites.

DRAFT

(b) All items of local cooperation specified in subsection (a) shall be provided at the time needed, as determined by the Chief of Engineers, and without cost to the United States; except in the event the Secretary of the Army selects a staged sediment retention structure or dredging alternative rather than the single stage sediment retention structure, any increase this selection causes in the cost of local cooperation requirements, as determined by the Secretary of the Army, will be reimbursed by the Federal government.

Sec. 3. Any goods and services purchased by the United States in connection with the project authorized pursuant to this section shall not be subject to the tax imposed by Chapters 82.04, 82.08, and 82.14 of the Revised Code of Washington and made applicable to contractors of the United States pursuant to section 82.04.190(6) of the Revised Code of Washington.

CONTENTS

COMMENTS OF THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

November 11, 1985

Honorable Robert K. Dawson
Acting Assistant Secretary of the
Army for Civil Works
Room 2E570 - Pentagon
Washington, D.C. 20310

Dear Mr. Dawson:

On May 10 and October 15, 1985, you sent us copies of reports of the Corps of Engineers on Mount St. Helens Sediment Control, Washington, with your recommendations. We have completed our review of this project as required under Executive Order 12322.

The Office of Management and Budget concurs in your recommendations and has no objection to your submitting these reports to the Congress.

Sincerely,

Randall E. Davis

Randall E. Davis
Associate Director
for Natural Resources,
Energy and Science

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

October 15, 1985

Honorable James C. Miller III
Director
Office of Management and Budget
Washington, D. C. 20503

Dear Mr. Miller:

On May 10, 1985, I submitted a copy of the report of the Chief of Engineers and accompanying supplement on Mount St. Helens Sediment Control, Washington (Toutle, Cowlitz, and Columbia Rivers). In my submittal letter I advised, in part, as follows:

> The Corps [of Engineers] is proceeding with CP&E [continuation of planning and engineering] studies. The objective of CP&E is to develop additional information on the sediment problem and the benefits and costs of alternative solutions. A final selection will be made at the Washington level next fall. We will coordinate with your office on the selection of the alternative that will be carried into final design.

In fulfillment of the commitment made last spring, I am submitting a copy of a memorandum of the Chief of Engineers on Mount St. Helens, Washington (Toutle, Cowlitz, and Columbia Rivers), together with the Mount St. Helens Decision Document, dated October 1985, prepared by the Portland District, North Pacific Division, Army Corps of Engineers. In his memorandum, the Chief of Engineers has affirmed his April 3, 1985, recommendation for implementation of a single stage Sediment Retention Structure (SRS).

The Mount St. Helens Decision Document, which presents the results of the CP&E studies, represents the best professional analysis possible, given the inherent uncertainty arising from the sediment budget estimate and altered hydrology of the affected watershed. The Decision Document sets a new standard for

Corps of Engineers planning reports and will serve as a model for future efforts. State, local, and Federal decision makers will find useful the explicit treatment of uncertainty and aid them in their appreciation of the trade-off between risk reduction and cost.

During the CP&E studies new information was developed on:

> The nature and magnitude of sediment deposition and the uncertainty inherent in the sediment budget estimate.

> The magnitude and location of flood damages and flood risks that exist in the Toutle and Cowlitz watersheds.

Additional information includes the following:

> That the significant flood risk is confined principally to a few specific locations within the existing leveed Cowlitz River flood plain.

> That no threat exists to Columbia River navigation, except from events whose probability of occurrence, in any given year, is very small.

> That sediment budget predictions are essential to defining the National Economic Development (NED) Plan.

> That 550 MCY, in the judgment of the Chief of Engineers, is the appropriate estimate of the sediment budget for the next 50 years.

> That the uncertainty that clearly is present is different than that encountered in other Civil Works projects. The Corps has less experience and less data on which to base decisions than typically is the case. And while Corps estimates of the total sediment budget have decreased from 1 BCY in 1982 to the present 550 MCY estimate, the amount of sand that must be managed has in fact gone up -- notwithstanding that actual measured sediment delivery, either

55-487 O - 86 - 2

to the Toutle or Cowlitz River, as seen in Table II-1 on page II-2, has declined since 1982.

> That the sources of sediment are (1) erosion of materials deposited by volcanic activity since 1980, and (2) sediment material to be made available for erosion as a result of volcanic activity yet to occur.

> That 115 MCY, that is, 21 percent of the 550 MCY estimated sediment budget, is derived from Corps models of sediment erosion and transport of materials deposited since 1980.

> That not less than 65 percent, and perhaps as much as 79 percent, of the estimated sediment budget is derived from adjustments made for analytical uncertainty and unpredictable future volcanic activity.

> That if the sediment budget proves to be less than 65 percent of the 550 MCY estimated sediment budget, the NED Plan is dredging.

This information and the analysis of alternatives suggest, as the Chief of Engineers points out, that either an SRS as recommended in May or dredging could be deemed acceptable in terms of affording a reasonable solution to the flood problem. In fact, these alternatives, as shown in Table VI-1 on page VI-4, have been designed to provide identical outputs; that is, the levels of flood protection available at the beginning of each water year are identical. However, with the dredging alternative, temporarily reduced levels of flood protection might be realized if during a water year an extremely low probability storm or mudflow event occurs. Should such an event occur, levels of protection would be restored by accelerated dredging.

I recognize that decision makers -- possessed of objectives, concerns, and premises different from my own -- may reach a different conclusion as to whether the SRS or dredging is the better plan. In this

connection, Table VI-4 on pages VI-9 and VI-10 of the Decision Document summarizes, in systematic fashion, the implications of differing beliefs about the sediment budget and other factors that affect the decision on the best permanent solution to the flood problem.

The April 3, 1985, report of the Chief of Engineers and accompanying supplement on Mount St. Helens Sediment Control contained a criterion for deciding under what conditions the Secretary of the Army could select an alternative to the single stage Sediment Retention Structure:

> . . . The Secretary of the Army may select and implement a staged sediment retention structure at the confluence of the Toutle and Green Rivers, or dredging alternative on the Toutle, Cowlitz, and Columbia Rivers if he determines that continuing monitoring of sedimentation and further analysis of benefits and costs provide compelling and convincing new evidence to justify selection of a staged retention structure or dredging alternative.

While the analysis contained in the Decision Document raises uncertainties about what ultimately may be the better solution, it is clear, in my judgment, that the Decision Document does not provide compelling and convincing new evidence to choose other than the SRS at this time. Further, Congress already has made known its preference for an SRS by authorizing its construction in Public Law 99-88, the Supplemental Appropriations Act, 1985. Therefore, I concur in the recommendation of the Chief of Engineers that the single stage Sediment Retention Structure be implemented.

The recommendation for implementation of the SRS, together with the analysis set forth in the Mount St. Helens Decision Document, clarifies the basis for final engineering and design and for budgetary decisions. As is true with other potential new construction starts nationwide, local cooperation agreements and consideration of Federal budgetary priorities will be essential to scheduling of implementation of the long-term solution. The Corps currently estimates that, during the first four years of construction of the SRS, the total cost of the retention structure will be $78 million, down considerably from the $136 million estimate contained in the Feasibility Report.

Sincerely,

Robert K. Dawson
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

MEMORANDUM TO THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO ATTENTION OF:

DAEN-ZA 11 OCT 1985

MEMORANDUM FOR THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

SUBJECT: Mount St. Helens Sediment Control Decision Document - ACTION MEMORANDUM

Attached is the Mount St. Helens Sediment Control Decision Document and the findings, conclusions, and recommendations of the District and Division Engineers.

Since the eruption of Mount St. Helens in 1980, the Corps of Engineers has been very active in recovery operations and the planning and implementation of permanent solutions to the problems caused by the eruption. The Portland District has been the office that has had the responsibility to plan, design and implement these solutions. It has not had to work alone, however, as the North Pacific Division office, the Office of the Chief of Engineers, and your staff have been actively involved. The resulting document is the result of the best of professional analysis and judgment at all levels throughout the Corps.

We recognize that the establishment of the sediment budget is one of the key factors in making a decision on the best permanent solution to the flooding problems associated with the sediment resulting from the eruption of Mount St. Helens. The Sediment Control Decision Document presents a sediment budget with a total volume of 550 million cubic yards (MCY) as the most likely budget. The document recognizes that, because of the budget's dependence upon the forecast of natural phenomena, the budget has inherent uncertainties. Among these are the problems associated with dealing with an active volcano. Our experience with the erratic behavior and the associated sedimentation problems of an active volcano is limited although we have augmented our knowledge by calling upon experts from the U.S. Geologic Survey, academia, and Japan. I have carefully considered the factors that influence the budget and have discussed it at length with my technical staff and agree with the experts both within and outside of the Corps who feel that the 550 MCY budget is the appropriate estimate upon which to base a decision. Yet, I acknowledge that there is clearly uncertainty present.

Recognizing that the sediment budget is the key element in the selection of an appropriate solution, we must not be lulled into complacency by the fallacy of a smooth average curve. The sediment budget is depicted by a smooth, exponentially decreasing curve and all the economic analyses are based upon that curve. In reality, the actual sediment curve will consist of peaks and valleys, which over time are expected to yield 550 MCY. The solution must be capable of safely and efficiently dealing with the peaks to avoid serious flooding.

I have reviewed the alternatives presented; dredging, and single and staged sediment retention structures (SRS), and believe that they have been evaluated fairly and equally. In considering these plans, I believe that the following factors are the most important in reaching a decision on the best plan to implement.

1. In comparison to the Feasibility Report, we now have more and better data to describe the magnitude of the problem, flooding in the Toutle and Cowlitz valleys, and more detailed analyses of the alternatives' ability to solve it.

2. All of the alternatives provide a reasonable reduction in flood damages; however, the SRS plans can better accommodate the uncertainties in the sediment budget and respond to the peaks in sediment delivery. In this regard, the SRS's are more proactive rather than reactive to changes in the sediment budget and have greater flexibility to handle future events. Dredging's mobilization requirements and capacity to move a large amount of sediment in a short period of time preclude this alternative from being responsive to successive events.

3. The social, economic, and environmental impacts in the Toutle and Cowlitz valleys and in the State of Washington are less for the SRS's than for dredging. The disposal problems associated with the 550 MCY budget are significant. We estimate that the dredging alternative would require approximately 124 MCY more disposal than the SRS alternative.

4. The sensitivity analysis shows the SRS's to be able to deal with a wider range of sediment budgets than can the dredging alternative. Even if the budget drops below the transition point you have not lost a great deal because the outyear dredging component of the SRS plan can be reduced, postponed, or deleted. In the meantime, the SRS continues

to provide the advantages I have pointed out above. In terms of cumulative budgetary outlays, the SRS is more costly for the first five years, but dredging then becomes more expensive for the remainder of the project life.

5. Additionally, I note that the SRS is currently supported by the state and local governments and Federal agencies while dredging is not.

The Comprehensive Plan and the Feasibility Report both concluded that an SRS was the best alternative to provide a permanent solution to the flooding problems resulting from the sedimentation from Mount St. Helens. The analyses recently completed under CP&E and documented in the Decision Document also reached the same conclusion. My staff and I have given careful consideration to the information provided in the document and to the discussions conducted with your staff. Therefore, I concur with the recommendations of the District and Division Engineers in recommending the NED plan consisting of a levee fix at Kelso, a single stage SRS at the Green River site with a spillway elevation of 125 feet, and initial and outyear dredging in the Toutle and Cowlitz Rivers. I also recommend that you concur in the selection of the NED plan and that the Corps proceed with its implementation.

The recommendations contained herein reflect information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation.

E. R. HEIBERG III
Lieutenant General, USA
Chief of Engineers

Enclosure

DA, North Pacific Division, Corps of Engineers
P. O. Box 2870, Portland, OR 97208-2870 8 October 1985

TO: CDR, USACE (DAEN-CWZ-A), 20 MASS AVE NW, WASH DC 20314-1000

1. I have reviewed the Portland District Commander's report evaluating alternative solutions for reducing the flood threat to communities along the Cowlitz River. I find the report presents a professional and comprehensive analysis of the complex problems associated with predicting sediment movement and flooding potential in a river basin devastated by an active volcano. Portland District incorporated the advice and guidance of recognized experts both inside and outside the Government. It is my opinion that the predicted sediment yields displayed in Chapter 2 and Appendix A represent the most reliable sediment forecast and problem statement that the engineering community can develop at this time.

2. In evaluating the Portland District report I first considered both the uncertainty of predicting sediment movement and the consequences of either underestimating or overstating the problem. During this evaluation I found that a part of the sediment budget is based on significant sediment yields from volcanic induced mudflows. It is my opinion that lesser but still significant sediment yields from the area above Coldwater and Castle Creeks would result from normal hydrologic processes regardless of volcanic activity. Thus, I find the flood threat to the communities of Longview, Kelso, Lexington, and Castle Rock, Washington to be real even during periods of reduced volcanic activity. Further, I recognize that solutions were formulated on average annual hydrologic and volcanic yields. In reality, yields during individual years will vary greatly above or below the average annual yield. Thus, although the alternative solutions appear to provide equal protection from the effects of sediment transport, they in fact, offer differing reactions to major hydrologic or volcanically induced events. It is my view that, because of the potential for extreme hydrologic events, multiple storm sequences, and/or volcanic actions, the plan including a sediment retention structure affords the highest degree of protection against flooding. Secondly, I considered the economic analysis, the views of local interests, and environmental impacts of the alternatives. In view of the above, I conclude that the plan identified as the NED plan provides the best solution to this complex problem.

3. The potential for disrupting commercial navigation on the Columbia River is another matter for concern. The District analysis predicts no navigation disruption from Mount St. Helens sediments unless major storms occur. Although this analysis is appropriate for the Decision Document, I believe navigation disruption could occur if major amounts of sediment are transported to the Columbia River when its flushing actions are reduced during a low flow period. Such disruption would be of short duration since adequate authority and procedures are in place to alleviate any disruptions.

4. In conclusion, I have carefully reviewed the data, analysis, and conclusions presented in this report. I concur in the Portland District Commander's recommendation to proceed with implementation of a sediment retention structure, with a 125 foot spillway height, on the North Fork Toutle River, with associated downstream dredging,and improvements to the levee at Kelso, Washington.

George R. Robertson

GEORGE R. ROBERTSON
Brigadier General, USA
Commanding

DECISION DOCUMENT OF THE DISTRICT ENGINEER

ERRATA

MOUNT ST. HELENS DECISION DOCUMENT

Please note that the total estimated Real Estate Costs for the 125-foot spillway SRS is $9.8 million as shown int Table III-6. The $12.2 million figure shown in Tables IV-14, B-9 and B-11 is incorrect.

SYLLABUS

This report analyzes management strategies for dealing with Mount St. Helens-related sedimentation and resultant flooding in the Toutle/Cowlitz/Columbia river system. Measures considered include a single sediment retention structure constructed in one stage (SRS) or multiple stages (MSRS), dredging, and levee raises at lower Cowlitz River Valley communities.

The recommended plan is a combination of a SRS (125-foot spillway) at the Green River site on the North Fork Toutle River, minimal levee improvements at Kelso, Washington, and dredging downstream from the SRS during its construction and in later years of the project when the reservoir has filled and sediment begins to pass over the spillway.

This is the National Economic Development (NED) plan, representing the program which will produce the greatest net economic benefits among those considered. In general, its social and physical environmental effects are considerably lower than any management strategy which depends principally on dredging. While requiring mitigation for fish runs into the upper North Fork Toutle River, this plan improves water quality and reduces environmental impacts everywhere downstream from its location. Because much of the sediment will be retained behind the structure, this program will avoid substantial downstream disposal site mitigation.

Of those sites feasible, the Green River site provides the best geologic and farthest upstream location for the earth embankment structure and sediment impoundment area. The structure alone will provide sufficient sediment storage to achieve 167-, 11-, 167-, and 118-year permanent safe flood protection (PSP) at Longview, Kelso, Lexington, and Castle Rock, respectively, over the 50-year project life. The PSP becomes 167-, 143-, 167-, and 118-years at the four communities with levee improvements. The SRS also provides storage for the sediment from a 100-year frequency storm. If monitoring programs suggest more capacity is needed in the reservoir for either rare events (floods or mudflows) or unexpectedly high erosion from the avalanche, it is possible, at additional cost, to raise the spillway and/or crest of the structure when needed.

This program will cost $231.1 million in 1985 dollars. Construction of the SRS, fish bypass, and levees accounts for $65.7 million of those costs. Initial dredging accounts for another $25.4 million and real estate and relocations are $18 million. Other costs, including O&M, monitoring, and outyear dredging total $122 million.

The SRS/levee improvement/dredging strategy recommended is the best alternative when economic, environmental, and engineering considerations are weighed. Preliminary analyses indicate that future raises of the SRS spillway are slightly more economical than outyear dredging along the Cowlitz River. This recommended plan provides more flexibility and safety in managing the unique sedimentation and flooding problem presented by the Mount St. Helens eruption than a dredging only or dredging and minimal levee raise strategy.

CHAPTER I - INTRODUCTION

BACKGROUND

History of Flooding

The 18 May 1980 eruption of Mount St. Helens deposited a debris avalanche of over 3.8 billion cubic yards (bcy) of silt, sand, gravels, and trees in the upper 17 miles of the North Fork Toutle River Valley. Another 50-60 million cubic yards (mcy) of material were deposited in the upper portion of the South Fork Toutle River Valley. The eruption devastated approximately 150 square miles of prime evergreen forests, mountain lakes, and the wildlife in that area. Mudflows, triggered by the eruption, carried large volumes of sediment from the debris avalanche into the Toutle/Cowlitz/Columbia river system. Widespread flooding along the Toutle and Cowlitz Rivers and blockage of the Columbia River navigation channel resulted. The hydrologic cycle of rainfall, runoff, infiltration, transpiration, evaporation, sublimation, and condensation was drastically altered.

Since 1980, large quantities of sediment have eroded from the avalanche and been transported by the river system. A substantial portion of that material has been deposited in the Cowlitz River, reducing its channel capacity and increasing potential flood heights. The large volume of sediment transported to the Columbia River after the initial eruption interrupted navigation on that waterway. The Corps of Engineers, Portland District, responded to the threat of flooding along the Cowlitz River and interruption of navigation on the Columbia River by implementing emergency measures along the three rivers impacted by the eruption and by studying future actions. These measures were designed to reduce the threat of flooding by retaining the sediment in the Toutle River basin, enlarging the clogged Cowlitz River channel, raising existing and constructing permanent new levees in urbanized areas along the Cowlitz River, and eliminating the threat to navigation by dredging in the Columbia River to restore the 40-foot deep by 600-foot wide navigation channel. Since 1980, the Corps of Engineers has spent over $375 million for emergency actions (see Table I-1) and will continue responding to any emergency threatening life and property.

TABLE I-1
MOUNT ST. HELENS EXPENDITURE SUMMARY
($000)

Appropriation/ Activity	Fiscal Year 1980	1981	1982	1983	1984	1985	TOTAL
Flood Control							
Coastal Emerg.							
Dredging	39,056	102,826	1,564	3,338	11	34	146,829
Structures	9,276	65,315	6,303	2,870	83	1,228	85,075
Spirit Lake	0	0	1,283	6,609	7,891	10,957	26,740
Monitoring	0	0	1,700	937	58	2	2,697
E&D, S&I	2,368	7,145	1,433	1,733	1,498	1,193	15,370
TOTAL	50,700	175,286	12,283	15,487	9,541	13,414	276,711
Operations & Maintenance							
TOTAL	20,300	21,900	7,900	7,700	7,187	7,325	72,312
General Investigations							
Sediment Control Permanent Solution							
TOTAL	0	0	37	2,616	1,780	5,855	10,288
Construction General							
100 Year Temporary Flood Protection (PL 98-63)	0	0	0	6,302	18,253	6,600	31,155
Spirit Lake	0	0	0	1,255	14	0	1,269
Sed. Control Perm. Sol.	0	0	0	0	0	0	0
TOTAL	0	0	0	7,557	18,267	6,600	32,424
GRAND TOTAL	$71,000	$197,186	$20,220	$33,360	$36,775	$33,194	$391,735

AUTHORITY AND PURPOSE

On 18 May 1982, President Reagan (through a Memorandum to the Secretary of Defense) requested that the Corps of Engineers prepare a report addressing alternative strategies for handling the projected movement of sediment. The strategies were to minimize the continuing problems of flood hazards and potential disruptions to navigation based upon engineering feasibility, economic merit and environmental sensitivity.

The report, "A Comprehensive Plan for Responding to the Long-term Threat Created by the Eruption of Mount St. Helens, Washington," was forwarded to the President in November 1983. The plan evaluated five alternative strategies for sediment control and analyzed six alternative outlets for stabilizing the level of Spirit Lake. In transmitting the Comprehensive Plan report, the Assistant Secretary of the Army for Civil Works (ASA[CW]) recommended finding a permanent solution to the sediment problem that could be forwarded for Congressional authorization and funding. In response to ASA(CW) direction, a Feasibility Report containing an Environmental Impact Statement was prepared and transmitted for further action in December 1984. The final Chief of Engineer's report, dated April 3, 1985, was reviewed by ASA(CW) and forwarded to the Office of Management and Budget on May 10, 1985, for review. Key elements of that report are: Analysis of the Sedimentation Problem, Evaluation of Structural Alternatives, Identification of the National Economic Development (NED) Plan, and a Cost-Sharing Formula. A summary of that information appears later in this document. Since preparation of the Feasibility Report, studies have been initiated under Continued Planning and Engineering (CP&E) authority as requested by ASA(CW).

The purpose of this document is to recommend a program of action by analysis and optimization of four sets of measures: a Single Retention Structure (SRS), a Staged Single Retention Structure (MSRS), dredging, and levee raises. With the exception of levee raise options, these measures will be evaluated alone and in appropriate combinations to identify the most effective program. In the dynamic Toutle/Cowlitz river system, unmanaged sedimentation can constantly raise water surface levels; consequently, protection from a given levee measure without sediment control would continually diminish.

Levees are most effective when combined with a retention structure or dredging program to maintain channel geometry. Therefore, levees were not considered singly.

STUDY AREA

The study area encompasses 1,200 square miles (sq. mi.) in southwest Washington, reaching north from the Columbia River to the headwaters of the Toutle River at Mount St. Helens. A vicinity map and a more detailed map of the study area are shown in Figures I-1 and I-2, respectively.

FIGURE I-1. VICINITY MAP

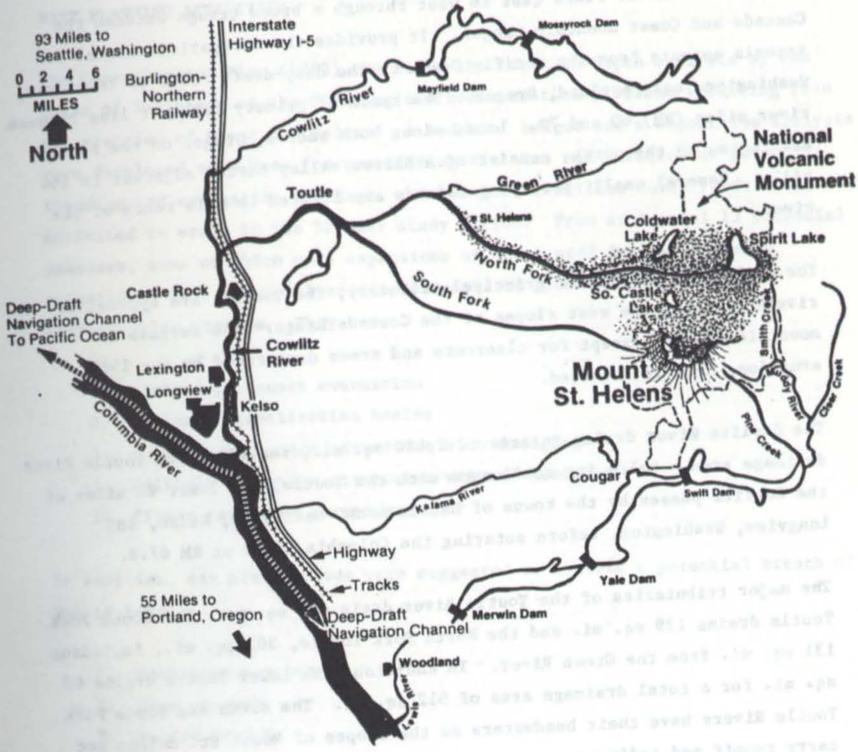

FIGURE I-2. STUDY AREA FOR THE DECISION DOCUMENT

The Columbia River flows east to west through a broad trough between the Cascade and Coast mountain ranges. It provides the navigation channel for vessels enroute from the Pacific Ocean to the deep-draft Ports of Vancouver, Washington, and Portland, Oregon. The reach of primary interest lies between river miles (RM) 60 and 72. Lands along both shores, Oregon on the south, Washington on the north, consist of a narrow valley bottom adjacent to low hills. Several small, low-lying islands are located in this reach of the river.

The Cowlitz River and its principal tributary, the Toutle, are typical of rivers draining the west slopes of the Cascade Range. The terrain is mountainous and, except for clearcuts and areas devastated by the 1980 eruption, heavily forested.

The Cowlitz River drains an area of 2,480 sq. mi., including the Toutle River drainage area. Below its confluence with the Toutle, the lower 20 miles of the Cowlitz passes by the towns of Castle Rock, Lexington, Kelso, and Longview, Washington, before entering the Columbia River at RM 67.8.

The major tributaries of the Toutle River drain 432 sq. mi. The South Fork Toutle drains 129 sq. mi. and the North Fork Toutle, 303 sq. mi., including 131 sq. mi. from the Green River. In addition, the lower Toutle drains 80 sq. mi. for a total drainage area of 512 sq. mi. The North and South Fork Toutle Rivers have their headwaters on the slopes of Mount St. Helens and carry runoff and sediment westward to the Cowlitz River. The North Fork Toutle River Basin includes three major lakes, South Castle, Coldwater, and Spirit.

The area affected by potential flooding varies from bottom land along the Cowlitz to uplands at the base of the mountains of the Cascade Range. Industrial riverfront and urbanized property lie adjacent to both the Columbia River and the downstream reaches of the Cowlitz River. Further up the Cowlitz, adjacent property is less populated, changing from urban to agricultural land use. The upper portion of the Toutle River Basin, except the volcanic and mudflow areas, is managed forestland.

PAST PLANNING ACTIVITIES

The Comprehensive Plan (1983) contained the first in-depth analysis by the Corps of Engineers of the flooding and sedimentation problems resulting from the eruption of Mount St. Helens. A sediment budget and a deposition analysis were developed as a base for quantifying the size and duration of potential flooding and navigation blockage. A total of 1 billion cubic yards (bcy) was estimated to erode in the 50-year study period. From an initial 13 potential measures, some of which were expansions of those used during emergency operations, five alternatives were proposed to permanently solve the sedimentation problem. They were:

1. Limited permanent evacuation
2. Sediment stabilization basins
3. Multiple retention structures with dredging
4. Multiple retention structures without dredging
5. Single retention structure

In addition, six alternatives were suggested to prevent a potential breach of Spirit Lake:

1. Permanent pumping
2. Open channel
3. Buried conduit
4. Tunnel (east) to Smith Creek
5. Tunnel (west) to N. Fork Toutle
6. Tunnel (west) to S. Coldwater Creek

Because a breach of Spirit Lake might have occurred with no action and in a very short timeframe, implementing a solution to that problem was accelerated. The South Coldwater Creek Tunnel alternative was selected, and construction was completed in April 1985. The lake is now stabilized at elevation 3440 feet National Geodetic Vertical Datum (NGVD). This work has produced the additional benefit of bypassing the water discharge from Spirit Lake around a portion of the highly erodible debris avalanche.

An optimization analysis based on least-cost for equal outputs was performed on the five alternatives identified in the Comprehensive Plan for solving the sediment problem. A Single Retention Structure (SRS) on the North Fork Toutle upstream from the Green River was the most cost-efficient on the basis of the then predicted erosion rates and timing and was selected as the NED Plan. A subsequent sensitivity analysis confirmed that the SRS remained the most cost-effective option, if the sediment budget was greater than approximately 54 percent of the predicted amount. This finding, as part of the Comprehensive Plan, was transmitted to the President in October 1983.

In a 3 November 1983 Memorandum to the Secretary of the Army, the Assistant Secretary of the Army for Civil Works (ASA[CW]) requested that further analysis concentrate on one or more SRS structures at the lowest feasible site in the basin. He further directed that other stages or structures should be planned for construction if and when needed. The rationale for proceeding with the feasibility stage of planning was founded in the unique nature of the problem created by the eruption. Consequently, the uncertainty of predicting erosion rates with field data from a very short post-eruption period necessitated a series of assumptions to predict the sediment budget. It was stated by the Assistant Secretary that notwithstanding the Corps' best estimates of erosion rates, actual stabilization of the Toutle basin by natural processes might occur more rapidly than anticipated. Thus, any programmed solution should provide flexibility to adjust to actual conditions.

Although the SRS was cost-effective over a wide range of the sediment budget, this did not constitute flexibility, as it requires a large initial cost. If the movement of sediment was less or slower than predicted, a smaller second stage would allow for significant saving of funds required from the Federal, state and local treasuries.

A feasibility study was initiated to recommend a permanent solution to the sedimentation and flooding problems for congressional authorization. The sediment budget was revised to indicate erosion of 650 mcy of material from the debris avalanche during the 50-year economic project life. A sensitivity analysis again concluded that the SRS was the best plan for handling erosion from the debris avalanche above 65 percent of the estimated sediment budget.

The Acting Assistant Secretary of the Army, after reviewing the Feasibility Report (1984), concluded that the concerns expressed in the 3 November 1983 memorandum were still valid. As a result, three options, SRS, staged SRS, and dredging, were to be evaluated during Continuing Planning and Engineering.

The sedimentation problem is recognized as both dynamic and unique for a variety of reasons. No historical data existed because the volcanic eruption altered the river systems in the basin. Selection of modeling procedures involved both executing various models, as data became available, and evaluating their performance. As knowledge expanded, the most recent sediment budget replaced the previous one. The forecasts used in the Feasibility Report superceded those in the Comprehensive Plan and, in turn, the new budget and analysis presented in this report will replace that from the Feasibility Report. Increased field data, modeling capability, and verification of model results with observed flood data have improved estimates. However, the lack of historical data for such a major change in basin characteristics poses a degree of uncertainty in analytically identifying a preferred plan.

STUDY SCOPE

At the direction of ASA(CW), the CP&E studies underway include analyses of three measures: dredging, a SRS, and a MSRS, all to an equal level of detail. Levees are also considered as additions to each of the above measures.

This study addresses the permanent solution to potential flooding on the Cowlitz River and possible disruption of navigation on the Columbia River caused by sediment buildup. It, therefore, focuses on the remaining problem of sediment buildup. This study includes: 1) updating the sediment budget; 2) redefining the problem consistent with that update; 3) describing and analyzing measures to deal with the redefined problem; 4) comparing the environmental effects of the measures; 5) determining a National Economic Development (NED) plan; and 6) recommending a solution to the problem.

CHAPTER II - SEDIMENT BUDGET AND PROBLEM STATEMENT

GENERAL CONSIDERATIONS

The purpose of this chapter is to provide an update of the sediment budget and revise the problem statement to reflect the updated budget. As this is done, comparisons to previous sediment forecasts and associated problem statements will be offered. A "base" condition of flood protection for lower Cowlitz River communities is authorized in PL 98-63. That base is the "without project" condition. A "no-action" scenario is presented as an analytical baseline only. The no-action alternative is a basic let-nature-take-its-course approach and will result in no expenditure of funds to reduce flood threat or damage. The flood damages under a "no-action" and a "base" response are described as part of this problem statement.

THE SEDIMENT BUDGET

Recent Rainfall Events, Flow Rates, and Measured Deposition

Basic data for sediment forecasting includes measurements of streamflow, erosion, sediment transport, and deposition. Records in the Toutle/Cowlitz/Columbia system relevant to this analysis start in water year (WY) 1981 and continue to the present. In that time period, annual precipitation in the area has approached the average during years 1981 and 1984, was below normal in 1985, and was above normal in 1982 and 1983. The 3 December 1982 storm, which produced an estimated 15-20 year North Fork Toutle River discharge of 16,300 cfs, remains the highest peak discharge observed. A series of storms in February 1982 had the largest sediment production. Table II-1 depicts streamflow and sediment movement in the system from WY 1981 through WY 1985. Though annual streamflows have remained near constant since 1982, the intensity of winter storms has decreased yearly, resulting in lower sediment yields and deposition.

Process for Establishing the Sediment Budget

The sediment budget forecasts total sediment yield and deposition over time in reaches of the Toutle and Cowlitz Rivers, and in the Columbia below its

TABLE II-1

SEDIMENT MOVEMENT AND STREAMFLOW IN THE TOUTLE/COWLITZ/COLUMBIA SYSTEM FOR WY 1981 THROUGH 1985

LOCATION	WATER YEARS				
	1981	1982	1983	1984	1985 1/
Tower Road 2/					
(Toutle RM 6.5)					
Sediment Yield	27 mcy	36 mcy	33 mcy	21 mcy	4 mcy
Streamflow 3/	4/	1.8	1.8	1.7	4/
LT-1 Dredging					
(Toutle RM 1.9-3.3)					
Sediment Removed	4/	0	3 mcy	5 mcy	2 mcy
Cowlitz River					
Deposition	4/	10 mcy	5 mcy	3 mcy	0
Cowlitz River					
Sump Dredging	4/	3 mcy	4 mcy	3 mcy	2 mcy
Cowlitz River					
Yield to Columbia	4/	23 mcy	21 mcy	10 mcy	4/

1/ Partial year, October through February

2/ Measured suspended sediment tonnage converted to cubic yards based on 95 lb/ft^3. Sediment yields include measured suspended sediment plus estimated unmeasured load. This multiple is lower than the 110 lb/ft^3 in-place density prior to erosion because, after transport, the material is redeposited in a loose, poorly-graded condition.

3/ In millions of acre-feet.

4/ In WY 1981 and 1985, there was no gaging station on the Cowlitz River that measured suspended sediment. As a result, it is not possible to make an estimate of sediment transported to the Columbia River.

confluence with the Cowlitz. Preparation of the budget began with characterization of the volcanic deposits, including their composition, volume, slope stability, and distribution. The budget predicted initial erosion rates on the avalanche, composition of eroded materials, limits of stream channel incision and widening, and average annual mudflow contributions. Erosion quantities were estimated using this information. The sediment transportation capabilities and depositional patterns on the Toutle, Cowlitz, and Columbia Rivers were then predicted.

Since estimates were based on the short period of record since 1980 and reflected only moderate to low frequency storm events, the Mount St. Helens Sediment Advisory Group (see Appendix A, Exhibits A-1 and A-2) was formed to review the estimating procedures. The group could concur in the forecast, recommend modifications in the analysis and recalculation, or suggest adjustments to outputs based on their professional judgment. After this expert screening, a recommended forecast was confirmed and used for various planning and operations activities.

The current forecast went through two rounds of analysis and expert review by the sediment advisory group. The first round led to a base estimate of 440 mcy. In reviewing this estimate, the consultants felt that it was low. Their comments were as follows:

"1. We have carefully reviewed the quantities and over-all results of the District's analysis and consider that a degree of conservatism is warranted in the estimate of avalanche yield over 50 years for the following reasons:

a. Even though the monitoring has been at a high quality and quantity level, hydrologic events during the 5 years since the eruption have not yielded a good sampling of what can occur in the future.

b. Modeling studies since our last meeting indicate that much more incision into the avalanche can occur than was previously considered.

c. The possible sequences of channel dregradation, widening and migration within the avalanche area are many and are difficult to predict. Such changes can greatly influence the rate by which erosion decreases with time.

2. As a consequence of this concern, the consultants suggest that the 50-year sediment yield of 440 mcy may be increased by 25 to 50 percent.

3. The primary change is an increase in the erosion downstream of Coldwater Creek because of the increased ability to incise as demonstrated by the model, and availability of material. The suggested yield increase depletes a total of only 15 percent of the avalanche material in 50 years, including 25 percent of the material in the Elk Rock-Coldwater reach."

These comments were considered to be legitimate and the base was increased by 25 percent to 550 mcy.

Thus, the 550 mcy forecast starts from the following premises:

(1) Volcanic and mudflow activity will remain constant at levels observed since the 1980 eruption.

(2) There will be no lake breakouts.

(3) Mudflows will keep stream channels unstable.

(4) Large storms will cause major disruptions of the stream channels, cut them deeply, and erode freshly exposed avalanche deposits.

(5) Channel incision will exceed 12 feet.

(6) Downstream from Coldwater, North Fork Toutle will continue to meander and erode all deposits above the existing stream profile.

(7) Only tributary streams will armor during the project life.

(8) Natural recovery will not significantly affect erosion.

(9) Consultants' recommendations are sound.

(10) The 550 mcy of well-graded material eroded from the debris avalanche would deposit as 640 mcy of poorly-graded material.

Current Deposition and Transportation Conclusions

The current recommended forecast projects 550 mcy of sediment yield from the avalanche between 1986 and 2035. This is a decrease of 17 percent from the Feasibility Report. The initial annual yield is substantially the same as in the Feasibility Report (see Figure II-1), but later exhibits lower volumes at any given point on the curve. The Comprehensive Plan budget is substantially higher and has heavy yield earlier than the current estimate.

However, the 550 mcy budget estimate refers to in-place material prior to erosion. There is a significant increase in volume between a given unit of in-place material prior to erosion and the same unit of material deposited as sediment (see Appendix A). Thus, 550 mcy of erosion bulks to 640 mcy of sediment. The cobbles and coarser gravels in this sediment will stay in the Toutle River. Most of the materials reaching the Cowlitz River will be sands, silts, and clays. Approximately 110 mcy of sand and fine gravels were predicted to deposit in the lower 20 miles of the Cowlitz River over the next 50 years with no action. Most fine sands and all of the clay and silt will enter the Columbia River with its capability to transport substantial volumes of sediment to the ocean. During the project period, more than 500 mcy of sediment is anticipated to leave the system through this sequence without substantial deposition in the Columbia River navigation channel. Table II-2 shows the movement of sediment through the Toutle/Cowlitz/Columbia river system with no action.

The Cowlitz River

Total sand yields to the Cowlitz have increased slightly from the Feasibility Report projection of 370 mcy to 380 mcy over 50 years, so that current annual volumes are now higher than the earlier projected estimates at any given point in time (see Figure II-2). Of greater importance is the pattern of sediment deposited in the Cowlitz over time. Figure II-3 shows that while the Feasibility Report anticipated a peak sediment accumulation of approximately 80 mcy around 2005 and scouring thereafter, the current forecast sees a steady accumulation through 2035 to approximately 120 mcy. As forecasts have changed from the Comprehensive Plan, the amount of expected sedimentation in the

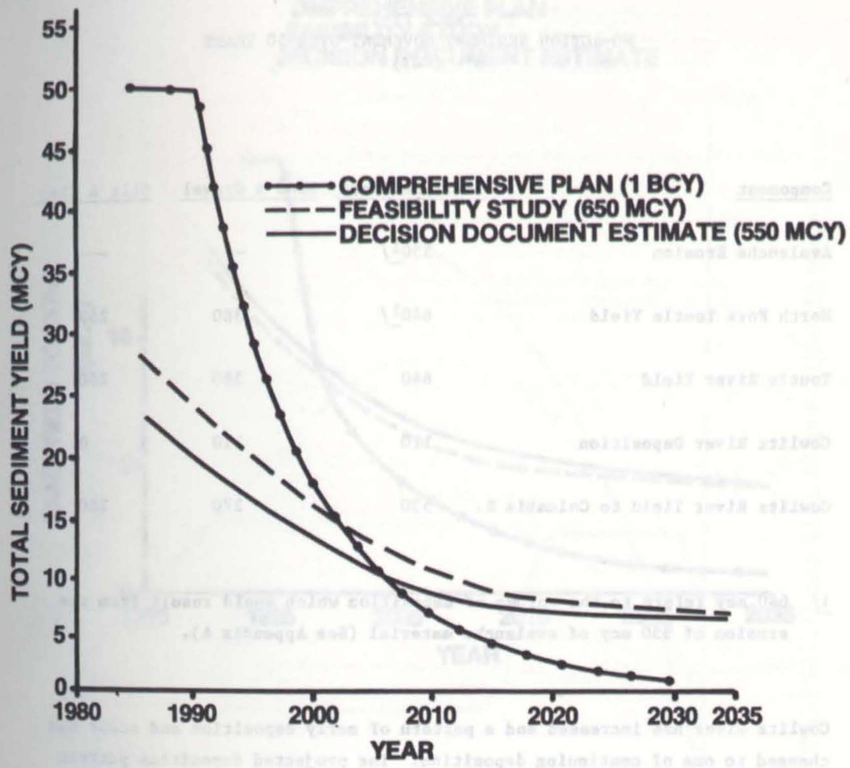

FIGURE II-1: TOTAL EROSION FROM THE AVALANCHE

TABLE II-2
NO-ACTION SEDIMENT MOVEMENT OVER 50 YEARS
(MCY)

Component	Total Sediment	Sand & Gravel	Silt & Clay
Avalanche Erosion	550 1/	---	---
North Fork Toutle Yield	640 1/	380	260
Toutle River Yield	640	380	260
Cowlitz River Deposition	110	110	0
Cowlitz River Yield to Columbia R.	530	270	260

1/ 640 mcy refers to the volume of deposition which would result from the erosion of 550 mcy of avalanche material (See Appendix A).

Cowlitz River has increased and a pattern of early deposition and scour has changed to one of continuing deposition. The projected deposition pattern along the Cowlitz River would raise the flood elevations at Castle Rock (RM 17.6) and delay the time at which flood elevations will peak at Longview/Kelso (RM 5.5). Figures II-4 and 5 show the comparative water surface elevations of the 100-year flood for this and the Feasibility Report projections under a no action condition.

The Columbia River

Figure II-6 illustrates that the sediment yield to the Columbia River with no action over the next 50 years is predicted to be somewhat less in this forecast than previous ones, 530 mcy, as compared to 564 mcy in the

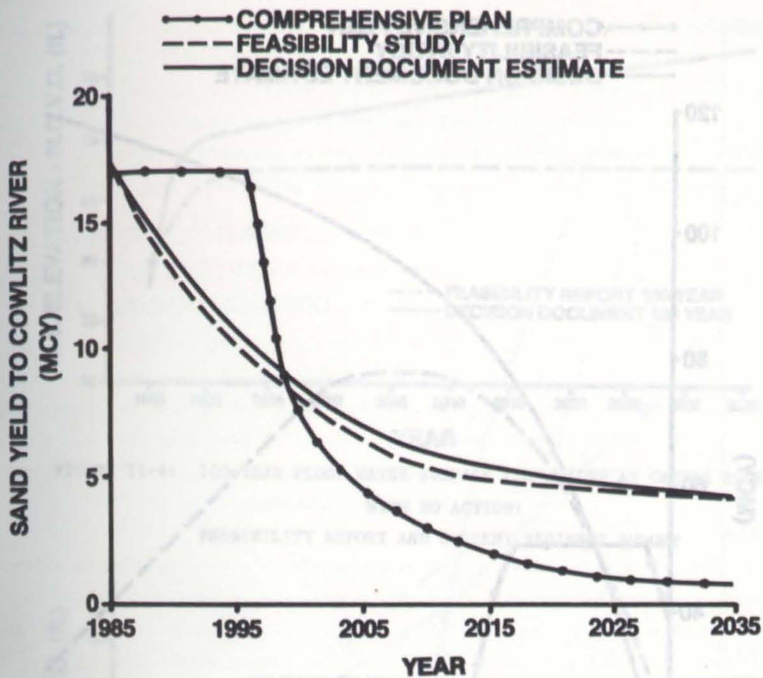

FIGURE II-2: SAND YIELDS TO THE COWLITZ RIVER WITH NO ACTION

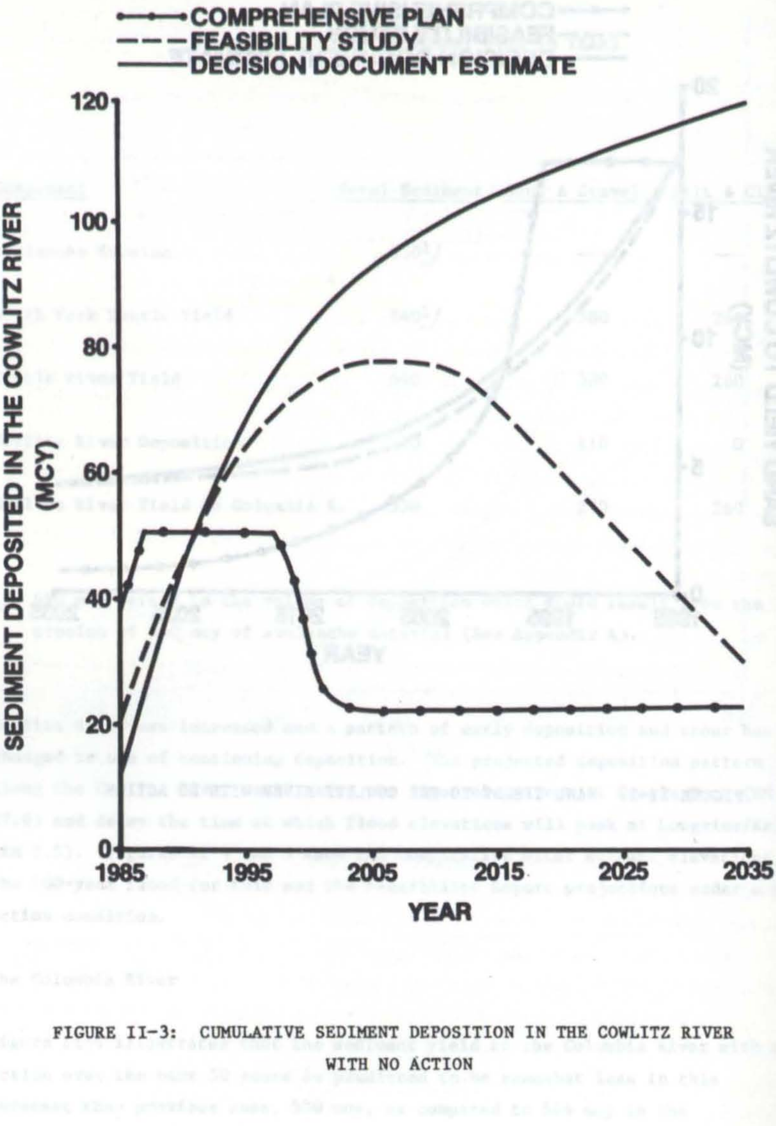

FIGURE II-3: CUMULATIVE SEDIMENT DEPOSITION IN THE COWLITZ RIVER WITH NO ACTION

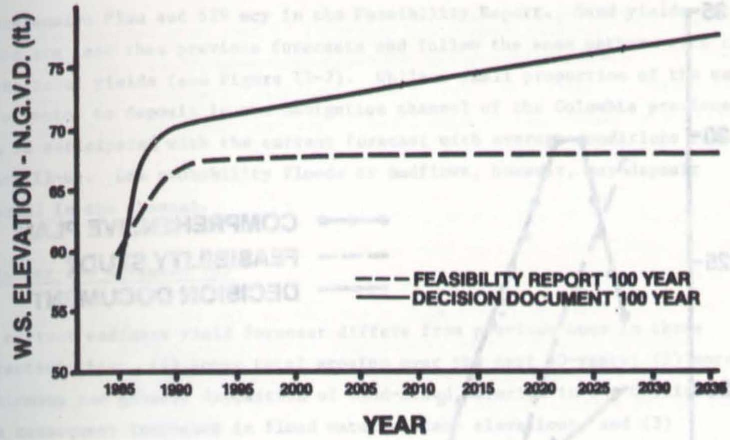

FIGURE II-4: 100-YEAR FLOOD WATER SURFACE ELEVATIONS AT CASTLE ROCK WITH NO ACTION: FEASIBILITY REPORT AND CURRENT SEDIMENT BUDGET

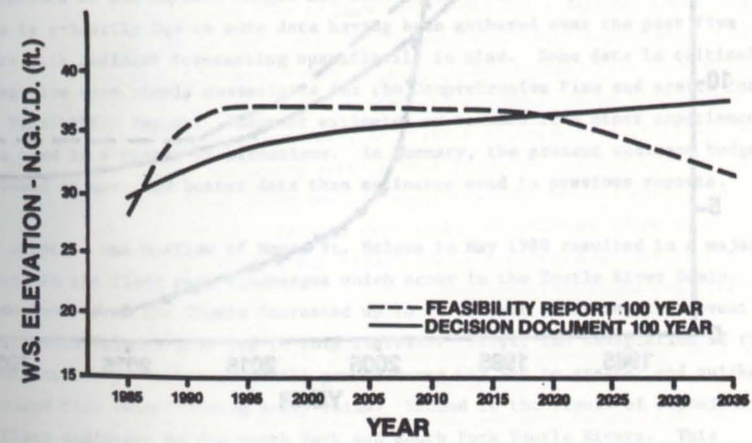

FIGURE II-5: 100-YEAR FLOOD WATER SURFACE ELEVATIONS AT LONGVIEW/KELSO WITH NO ACTION: FEASIBILITY REPORT AND CURRENT SEDIMENT BUDGET

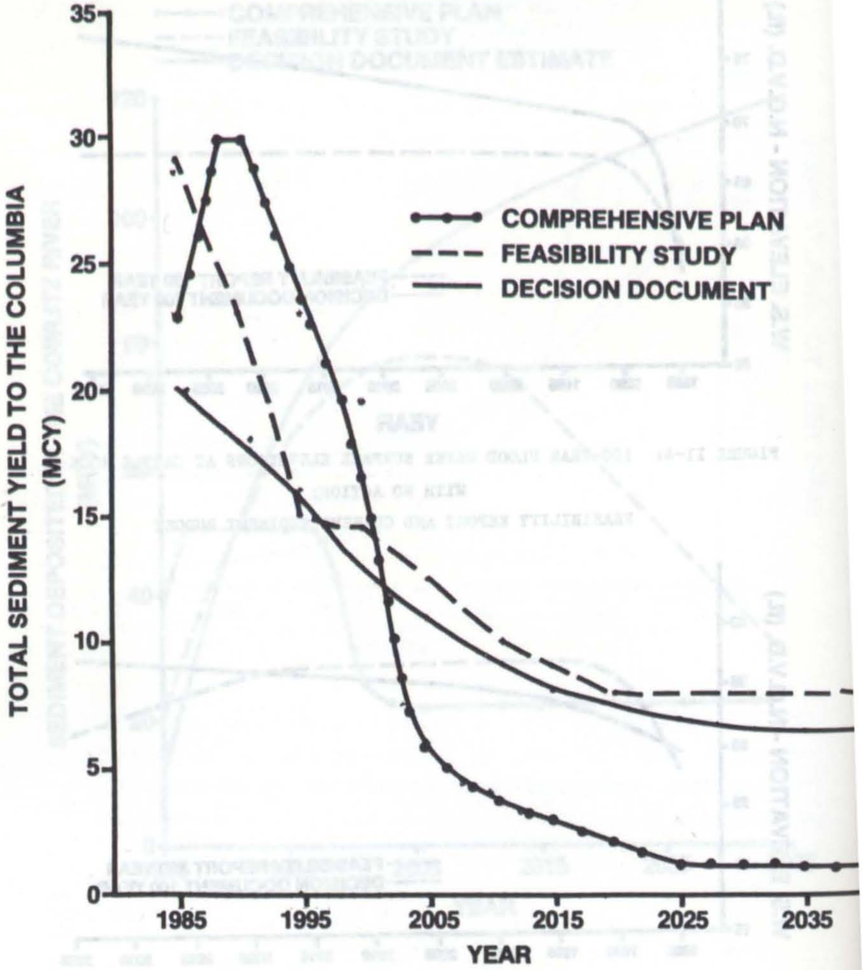

FIGURE II-6: SEDIMENT YIELD TO THE COLUMBIA RIVER
WITH CURRENT AND PAST SEDIMENT FORECASTS

Comprehensive Plan and 629 mcy in the Feasibility Report. Sand yields with no action are less than previous forecasts and follow the same pattern with time as the total yields (see Figure II-7). While a small proportion of the sand was expected to deposit in the navigation channel of the Columbia previously, none is anticipated with the current forecast with average conditions (see Figure II-8). Low probability floods or mudflows, however, may deposit material in the channel.

Basis for the Estimate (E)

The current sediment yield forecast differs from previous ones in three characteristics: (1) lower total erosion over the next 50-years; (2) more continuous and greater deposition of sand-sized material in the Cowlitz River with consequent increases in flood water surface elevations; and (3) expectation of minimal sand deposition in the Columbia River navigation channel attributable to erosion from eruption materials.

Components of the current budget are more refined than in previous forecasts. This is primarily due to more data having been gathered over the past five years with sediment forecasting specifically in mind. Some data in critical categories were simply unavailable for the Comprehensive Plan and scarce for the Feasibility Report. Judgment estimates or volumes from other experience were used in a number of situations. In summary, the present sediment budget is based on more and better data than estimates used in previous reports.

The eruption and mudflow of Mount St. Helens in May 1980 resulted in a major change in the flood peak discharges which occur in the Toutle River Basin. Flood peaks from the Toutle increased up to 40 percent following this event. Two general factors have led to this increase. First, the devastation of the upper watershed which removed all ground cover has led to greater and quicker overland flow runoff during heavy rains. Second is the result of deposition of finer sediments in the North Fork and South Fork Toutle Rivers. This sediment decreased flow resistance, which changed travel times of flood runoff. The more concurrent flood hydrographs among the North Fork, South Fork, and Green Rivers resulted in increased peak flood discharges in the lower Toutle. The debris avalanche is as much as 600 feet thick; the erosion

channels meandering across it cut as far as 50 feet deep into the materials. There is little chance of enough stabilization under these conditions for significant revegetation. What plants establish themselves will almost certainly be undermined by normal hydrologic processes. Any revegetation that is occurring is primarily away from the avalanche.

Finally, it must be kept in mind that the sediment estimate reflects long-term average conditions. Part of that average is accounted for by low probability floods and mudflows, events in which substantial volumes of sediment are transported. Thus, in a year with a low probability event, sedimentation can far exceed the average curves represented in the illustrations of the budget outputs. On the other hand, low flow periods will produce less sediment than shown on the average curves.

FLOOD CONDITIONS

During the wet season, November through March, rainfall is typically of light to moderate intensity and continuous over an extended period of time. Flood-producing storms occur generally during these months but are not uncommon in late fall or early spring. High intensity storms are a result of a higher than normal pressure gradient between an Aleutian low pressure area and a Pacific high pressure area. The resulting strong flow of moist marine air into the Pacific Northwest causes heavy precipitation, often in flood-producing quantities. These weather systems often occur as part of a series of fronts which approach the coast with typically 4 to 7 days between fronts. Annual flood-frequency data on the Toutle and possible sedimentation in the Cowlitz are shown in Table II-3.

The U.S. Geological Survey (USGS) recorded 192 flood peaks above the base level of 9000 cfs over the 54-year period of record at 'Toutle River near Silver Lake' gaging station. Multiple 'large' events have also occurred during a single water year. Peaks of 43,200 cfs and 25,300 cfs were recorded during water year 1978 on 2 December and 13 December, respectively. During water year 1982, floods of approximately 35,000 cfs occurred on 24 January and 20 February. Using partial duration frequency computations, a discharge of 35,000 cfs could be expected to be equaled or exceeded an average of 20 to 25

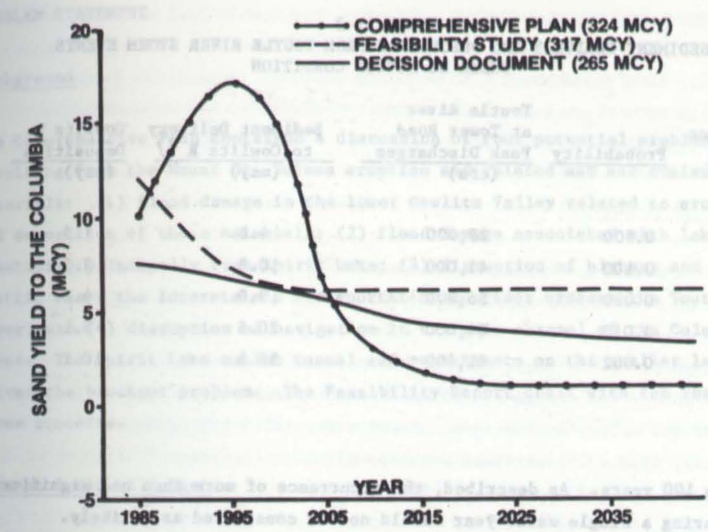

FIGURE II-7: SAND YIELD TO THE COLUMBIA RIVER WITH NO ACTION

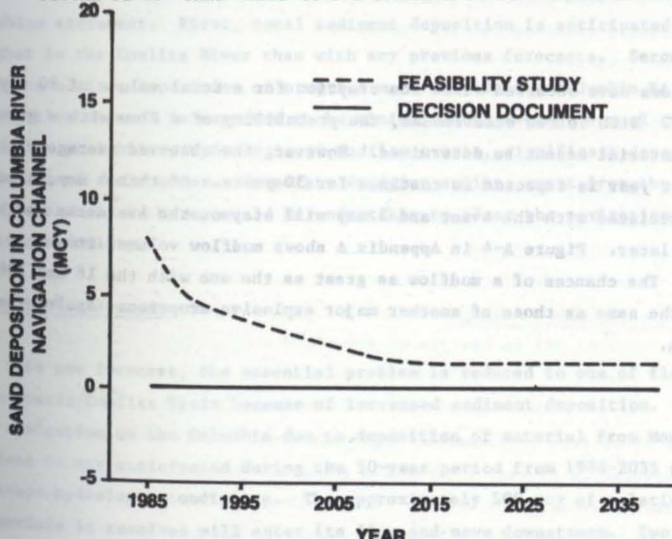

FIGURE II-8: SAND DEPOSITION IN THE COLUMBIA RIVER NAVIGATION CHANNEL WITH NO ACTION

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TABLE II-3
SEDIMENT DELIVERY AND DEPOSITION FROM TOUTLE RIVER STORM EVENTS
UNDER NO ACTION CONDITION

Average Exceedence Interval (yr)	Probability	Toutle River at Tower Road Peak Discharges (cfs)	Sediment Delivery to Cowlitz R 2/ (mcy)	Cowlitz R. Deposition (mcy)
2	0.500	25,000	4.8	1.3
10	0.100	41,000	10.8	3.0
50	0.020	56,800	19.0	4.8
100	0.010	64,000	20.6	5.1
500	0.002	81,400	38.5	10.1

times in 100 years. As described, the occurrence of more than one significant flood during a single water year should not be considered as unlikely.

Mudflows

Three mudflows have occurred since the eruption for a total volume of 20 mcy of sediment. With so few occurrences, the probability of a flow with a given volume of material cannot be determined. However, the observed average rate of 5 mcy per year is expected to continue for 50 years. Of that 5 mcy, 2 mcy will be associated with the event and 3 mcy will stay on the avalanche and be discharged later. Figure A-4 in Appendix A shows mudflow volumes from 1980-1985. The chances of a mudflow as great as the one with the 18 May 1980 blast are the same as those of another major explosive eruption. Again, these are unknown.

PROBLEM STATEMENT

Background

The Comprehensive Plan contained a discussion of four potential problem areas resulting from the Mount St. Helens eruption and related ash and avalanche materials: (1) flood damage in the lower Cowlitz Valley related to erosion and deposition of these materials; (2) flood damage associated with lake breakouts, principally from Spirit Lake; (3) disruption of highway and rail traffic where the Interstate 5 transportation corridor crosses the Toutle River; and (4) disruption of navigation in the main channel of the Columbia River. The Spirit Lake outlet tunnel and embankments on the smaller lakes solved the breakout problem. The Feasibility Report dealt with the remaining three concerns.

Current Sediment Budget

This sediment budget differs from previous ones in two ways pertinent to the problem statement. First, total sediment deposition is anticipated to be higher in the Cowlitz River than with any previous forecasts. Second, even with no action, deposition of eruption materials in the Columbia River navigation channel is expected to be minimal under average annual conditions. With low probability hydrologic or mudflow events, significant deposition in the channel could occur. Immediate dredging action, apart from the long-term programs analyzed here, would be undertaken to clear the navigation channel in that eventuality.

Problem Restatement

By this new forecast, the essential problem is reduced to one of flooding in the Toutle/Cowlitz Basin because of increased sediment deposition. Disruption of navigation on the Columbia due to deposition of material from Mount St. Helens is not anticipated during the 50-year period from 1986-2035 under average hydrologic conditions. The approximately 500 mcy of relatively fine materials it receives will enter its flow and move downstream. Two problems remain to be addressed by this document: (1) flooding in the lower Cowlitz,

particularly at Longview, Kelso, Lexington, and Castle Rock and (2) possible land traffic interruptions in the I-5/Burlington Northern Railroad corridor as the result of a flood event. Alternative measures to minimize damages associated with these two problems will be considered and a recommended program developed.

Effects of No Action

Given no action and realization of the 550 mcy forecast, average annual flood damages of $43,411,000 can be expected. In the Feasibility Report, these damages were set at $127,504,000. The lower number with this report reflects the change in the sediment budget, the change in sediment delivery along the Cowlitz River, the change to 1985 dollars, revised safe levee heights at Longview and Kelso, and using an interest rate of 8-5/8 percent. In both estimates, once a 2-year flood overtops permanent levees, abandonment of the area is assumed and no future damages are assessed. Costs of that abandonment, e.g., to utilities and infrastructure, are not included in these estimates. If these costs were included, the need for some solution to the flooding problem would be further emphasized. Hence, the damage estimates here are conservative.

This abandonment point occurs at Castle Rock in 1987, at the I-5 and railroad bridges in 1988, at Lexington in 1991, and, finally, at Kelso in 1996. While abandonment is not projected at Longview, frequent flooding of commercial, industrial, and residential land proximate to the Cowlitz River could be anticipated with no action.

Effects with the Base Condition

Definition

Public Law 98-63 (the Supplemental Appropriations Act of 1983) authorized interim measures to protect communities along the Cowlitz River from St. Helens' blast-related flood damage. In response, the Corps has adopted a minimum level of protection, a base condition, in place of the traditional "no-action" alternative for this analysis. The base was established in the

Feasibility Report as the level of protection afforded by channel geometry as recorded in November - December 1983. This level was selected because it was: (1) documented by surveys, and (2) achievable on a continuing basis. Base level protection is that provided by permanent levees, i.e. Permanent Safe Protection (PSP). Longview has 71-year, Kelso has 3-year, Lexington has 77-year, and Castle Rock has 71-year PSP for a base standard. These figures vary from those in the Feasibility Report because they are calculated with the HEC-2 model using measurements taken in the Cowlitz River over the past five years and revised safe levee heights were used. The HEC-6 model used previously proved difficult to verify against field measurements.

Temporary Emergency Protection (TEP) as of 1982, with all interim measures implemented, including dredging, maintenance of permanent levees, and augmentation of temporary levees, was at or better than the 100-year event. However, TEP is designed primarily for one-time protection of property. Hence, by Corps standards, it cannot be considered as permanent. These standards pertain under current Federal Flood Insurance Programs.

Effects

With maintenance of the base by dredging, annual damages would be reduced to a residual of $16,505,000. The average annual cost for this reduction is put at $13,080,000. With only 3-year PSP, it is obvious that the greatest single element of these damages, $13,912,000 annually, would be at Kelso. Virtual complete inundation would occur at Kelso several times in the 1986 to 2035 period under this scenario. Minor pooling in low lying areas behind levees and inundation of unleveed areas by streamflows would characterize flooding in other areas of the Cowlitz Valley. With base condition dredging on Toutle River, damage of $1 M or more would not be accrued at the transportation corridor until a storm of 105 year recurrence interval happens. With Cowlitz River dredging, damage of $1 M or more would result from a 55-year flood.

The Columbia River

With the new forecasts, no navigation disruptions are predicted due to Mount St. Helens sediment unless low-frequency storms occur. Hence damages and

costs for dredging in the Columbia no longer contribute to either the no action or base conditions. The river is still expected to receive and transport over 500 mcy of sediment over the next 50 years. However, sediment delivery due to low probability flood events may require dredging to maintain authorized navigation channel depths.

Relationship to Feasibility Report

Three major distinctions exist between this description of the no-action and base conditions and that found in the Feasibility Report. First, minimal sediment deposition is forecast in the Columbia River, hence no disruptions to navigation are foreseen. Second, the present value of average annual losses due to flooding in the Cowlitz Valley is greatly reduced in the no-action condition. Third, most damage can be expected to occur at Kelso under this forecast, where Longview showed the greatest average annual damage previously. Longview was expected to have $102,100,000 average annual damages in the Feasibility Report, compared to Kelso's $6,100,000. The damages are now set at $3,500,000 for Longview and $20,700,000 for Kelso. The changes in these damage estimates will be discussed further in Chapter IV.

Pre-Eruption and Base Protection Levels

The pre-eruption and base protection levels provided for Longview, Kelso, Lexington, and Castle Rock are displayed on Table II-4.

TABLE II-4
PROTECTION LEVELS
(average exceedence interval, years)

	Pre-Eruption	Base Dredging w/Exist. Levees 4/
Longview	100-year 1/	71-year
Kelso	100-year 1/	3-year
~~Lexington~~	Less than 10-year 2/	77-year
Castle Rock	Greater than 100-year 3/	71-year

1/ Based on Portland District interim letter report, entitled, Drainage District Condition Study on Safe Water Surface Levels, dated May 1978. One-hundred-year PSP is the minimum level which existed. Freeboard of 10 feet (at Longview) and 5 feet (at Kelso) were not incorporated into this protection level determination (i.e., the PSP was probably greater).

2/ Inside toe of levee prior to the 1980 eruption was used as the safe height for PSP determination.

3/ Three feet below the crest of Castle Rock levee prior to the 1980 eruption was used as the safe levee height and for determination of PSP.

4/ Based on dredging level authorized by PL 98-63. This has been defined as dredging to maintain the channel geometry existing in December 1983.

CHAPTER III - DESCRIPTION AND ANALYSIS OF MEASURES

INTRODUCTION

The measures under consideration for dealing with the sedimentation and resultant flooding problems are reviewed below. Three basic possibilities are presented: (1) dredging to maintain or increase flood protection; (2) building a sediment retention structure in one stage (SRS); and (3) building a retention structure in multiple stages (MSRS). Raising existing levees is considered as an added increment to each of the three basic strategies. In the dynamic Toutle/Cowlitz system, levee improvements provide an adequate level of protection for the affected communities only if sediment aggradation in the channel stops. Once the measures are reviewed they will be combined into the complete management strategies that comprise the alternative plans. The alternatives are analyzed on economic and environmental criteria in Chapters IV and V.

DREDGING

Three dredging alternatives were analyzed: (1) minimal dredging to maintain the base condition; (2) an intermediate program which provides protection at the 100-year level for all communities except Kelso; (3) the maximum level, which provides protection above the 100-year level except at Kelso.

Anticipatory dredging, through the establishment and maintenance of Sediment Stabilization Basins (SSB), is the preferred method for maintaining protection on the Cowlitz River. The SSB slows the velocity of water by overdredging of a reach to create a sump. Consequently, bed material sediments deposit there. The SSB can be allowed to fill or maintain through additional dredging. The LT-1 site is an SSB. It has trapped nearly 13.4 mcy of sediment between water years 1981-1985 with a small sump and intensive maintenance dredging.

For Toutle River dredging, SSB's will be operated simultaneously at the LT-1, LT-3 and NF-1 sites. These three sites offer approximately 8.5 mcy of sediment detention volume at the beginning of the flood season. Depending on

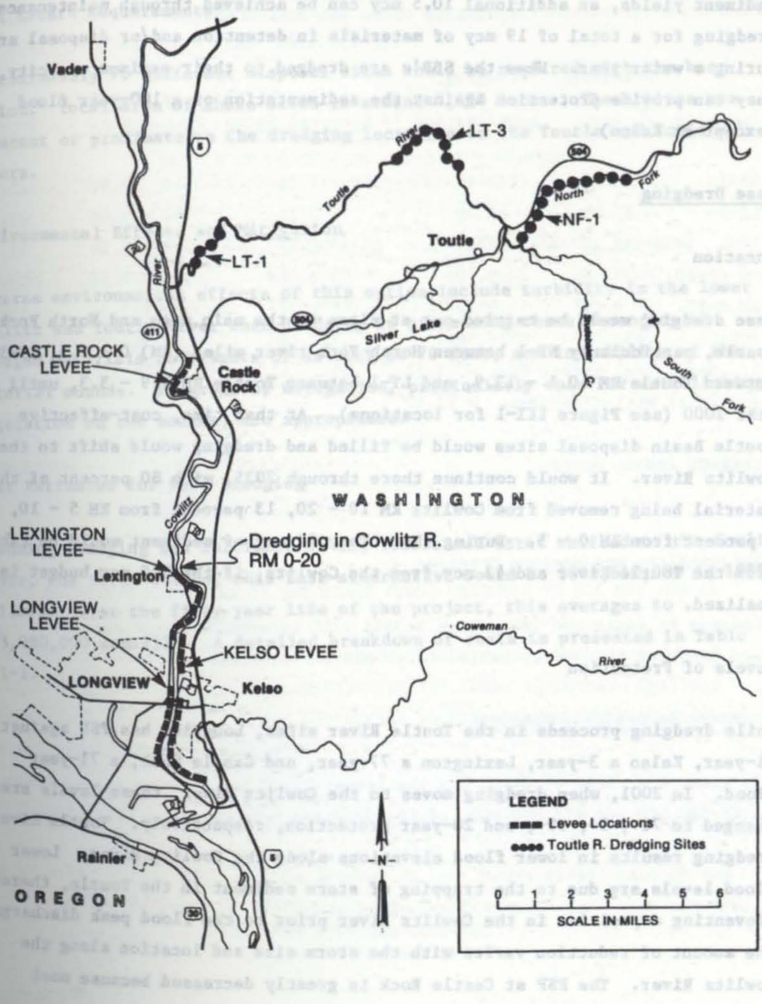


FIGURE III-1: DREDGING AND LEVEE LOCATIONS

sediment yields, an additional 10.5 mcy can be achieved through maintenance dredging for a total of 19 mcy of materials in detention and/or disposal areas during a water year. When the SSB's are dredged to their maximum capacity, they can provide protection against the sedimentation of a 100-year flood (except at Kelso).

Base Dredging

Location

Base dredging would be carried out at sites on the main stem and North Fork Toutle, particularly NF-1 between North Fork river miles (RM) 0 - 5.5, LT-3 between Toutle RM 10.4 - 13.9, and LT-1 between Toutle RM 1.9 - 3.3, until the year 2000 (see Figure III-1 for locations). At that time, cost-effective Toutle Basin disposal sites would be filled and dredging would shift to the Cowlitz River. It would continue there through 2035, with 80 percent of the material being removed from Cowlitz RM 10 - 20, 13 percent from RM 5 - 10, and 7 percent from RM 0 - 5. During that time, 92 mcy of sediment would be taken from the Toutle River and 42 mcy from the Cowlitz, if the 550 mcy budget is realized.

Levels of Protection

While dredging proceeds in the Toutle River sites, Longview has PSP against a 71-year, Kelso a 3-year, Lexington a 77-year, and Castle Rock, a 71-year flood. In 2001, when dredging moves to the Cowlitz River, these levels are changed to 71-, 3-, 59-, and 20-year protection, respectively. Toutle River dredging results in lower flood elevations along the Cowlitz River. Lower flood levels are due to the trapping of storm sediment in the Toutle, thereby preventing deposition in the Cowlitz River prior to the flood peak discharge. The amount of reduction varies with the storm size and location along the Cowlitz River. The PSP at Castle Rock is greatly decreased because most deposition during a storm occurs in this area.

Real Estate Requirements

Approximately 70 different disposal sites would be required with the base option. Total area of these sites is around 4,400 acres. These sites are adjacent or proximate to the dredging locations in the Toutle and Cowlitz Rivers.

Environmental Effects and Mitigation

Adverse environmental effects of this option include turbidity in the lower Cowlitz and Toutle River when dredging is proceeding there, mounding of dredged materials to heights of as much as 70 feet, and instability of the material mounds. Programs of mitigation, particularly ones for establishing vegetation on the mounds, are appropriate.

Cost Estimates for Base Dredging

Assuming dredging was initiated on the Toutle and later shifted to the Cowlitz River, the total cost of this base alternative would be $346,640,000 in 1985 dollars. Over the fifty year life of the project, this averages to $13,080,000 annually. A detailed breakdown of costs is presented in Table III-1.

TABLE III-1
ESTIMATED COSTS FOR BASE DREDGING
($ M of 1985 dollars)

Location	Dredging Quantity mcy	Dredging, Real Estate 1/ & Mitigation 2/	Rehab. of Disposal Sites	Bank Prot.	Mon.	Total
NF-1	53.00	115.90	3.00	3.14	7.90	129.94
LT-3	27.00	53.70	0.71	3.40	3.40	61.21
LT-1	12.20	23.80	0.68	2.80	4.50	31.78
RM 10-20	33.20	63.50	3.04	0.00	17.50	84.04
RM 0-10	9.10	19.40	2.77	0.00	17.50	39.67
TOTALS	134.50	276.30	10.20	9.34	50.80	346.64

1/ Total Real Estate Cost = 9.24
2/ Total Mitigation Cost = 22.67

AVERAGE ANNUAL COSTS: 13.08

Intermediate and Maximum Dredging

Changes in costs and protection levels with intermediate and maximum dredging are detailed in summary tables III-2 and III-3, respectively.

Summary on Dredging Measures

To summarize, base dredging has the lowest total and average annual costs, $346,640,000 and $13,080,000, of the dredging measures (see Table III-3).

TABLE III-2
COSTS OF DREDGING MEASURES
($ M of 1985 dollars)

Measure	Initial	O & M	Other	Total	Avg. Annual
Base	276.29	10.20	60.15	346.64	13.08
Intermediate	403.78	12.20	60.15	476.13	16.50
Maximum	593.43	15.40	60.15	668.98	22.08

The amount of protection increases as costs do; the maximum dredging provides the greatest protection (see Table III-3).

TABLE III-3
LEVELS OF PROTECTION (PSP) WITH DREDGING
(average exceedence intervals)

	With Toutle R. Dredging				With Cowlitz R. Dredging			
Measure	LG	KL	LX	CR	LG	KL	LX	CR
Base	71	3	77	71	71	3	59	20
Intermediate	167	11	167	118	149	10	143	63
Maximum	303	56	313	200	270	50	263	117

LEGEND:

LG = Longview   LX = Lexington

KL = Kelso   CR = Castle Rock

SINGLE RETENTION STRUCTURE IN ONE STAGE (SRS) DESIGNED TO 550 MCY BUDGET

Five variants of the SRS were considered. Roller compacted concrete and embankment were considered as construction for these variants. Spillway descriptions presented here are applicable in either case. Costs pertain to the construction method specified.

Location

Any selected SRS or MSRS will be located at the "Green River" site on the North Fork Toutle River, 2 miles upstream from its confluence with the Green River (see Figure III-2).

Heights

The spillway heights considered in this study are 50, 100, 125, 150, and 200 feet. These correspond to elevations 865, 915, 940, 965, and 1,015 feet NGVD.

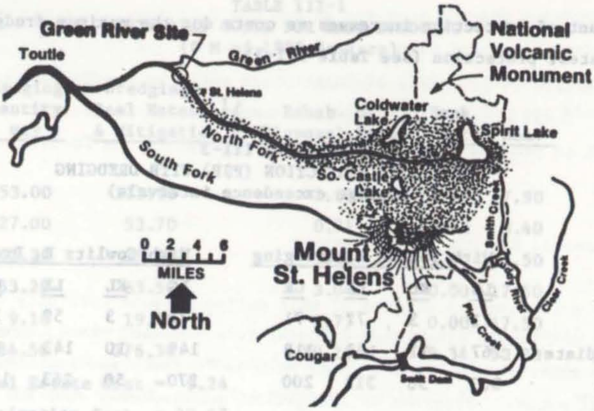


FIGURE III-2: GREEN RIVER SITE

Retention Capabilities

The sediment retention characteristics of the SRS change as sediment fills the available storage. Variations in streamflow will cause infinite changes in trap efficiency, but there will be three general phases of sediment retention as shown on Figure III-3. The first will be as the depositional surface rises toward the spillway crest. During this phase, all sediment sizes will be trapped in the reservoir area. The second phase begins when deposition reaches the spillway crest and lasts until the slope of the depositional surface is approximately one-quarter of the original stream slope (S/4). Only sand and gravel are expected to deposit during this second phase. Some sand transport through the SRS can be expected during this time. The final phase is the deposition of gravel and coarse sand, until the depositional slope is about one-half the original stream slope (S/2).

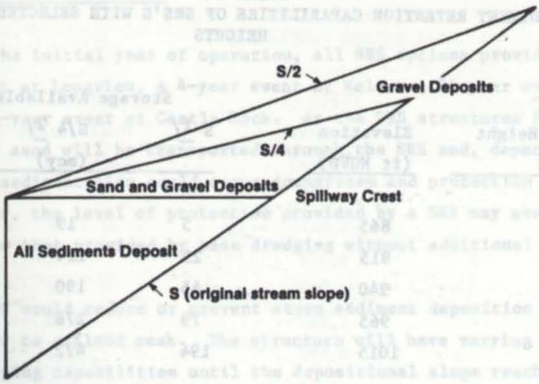


FIGURE III-3: SEDIMENT RETENTION PHASES

Table III-4 reports the sediment retention capabilities of structures with the various spillway heights. Table III-5 shows the movement of sediment through the Toutle/Cowlitz/Columbia River System with the 125 foot SRS and downstream Cowlitz dredging. The no-action sediment movement is shown in Table II-1, p. II-2.

Impoundment Areas

The area required for the impoundments of various options is shown in Table III-5. As the height of the spillway increases the area of the impoundment expands.

TABLE III-4
SEDIMENT RETENTION CAPABILITIES OF SRS'S WITH SELECTED SPILLWAY HEIGHTS

Spillway Height (ft)	Elevation (ft NGVD)	Storage Available S 1/ (mcy)	S/4 2/	S/2 3/
50	865	5	19	32
100	915	25	114	161
125	940	45	190	258
150	965	79	276	435
200	1015	194	472	760

1/ Storage to spillway crest above existing ground.
2/ Infill slope where only very coarse sands, gravels, and cobbles are retained.
3/ Maximum theoretical storage.

TABLE III-5
SPILLWAY HEIGHTS AND SEDIMENT IMPOUNDMENT AREA
(acres)

Spillway Height (ft)	Area @ Spillway Crest (acres)	Area@ S/4 1/ (acres)	Area@ S/2 2/ (acres)
50	150	540	860
100	510	1500	2510
125	915	2050	3200
150	1325	2550	3825
200	2100	3500	4950

1/ Point at which only coarse sands, gravels, and cobbles are retained.
2/ Maximum storage at one-half the existing ground slope.

Levels of Protection

In the initial year of operation, all SRS options provide PSP for a 100-year event at Longview, a 4-year event at Kelso, a 91-year event at Lexington, and a 71-year event at Castle Rock. As the SRS structures fill to S/4 and then S/2, sand will be transported through the SRS and, depending on the SRS size, new sedimentation could occur downstream and protection will drop. In that event, the level of protection provided by a SRS may eventually deteriorate below that provided by base dredging without additional dredging.

A SRS would reduce or prevent storm sediment deposition in the Cowlitz River prior to a flood peak. The structure will have varying storm sediment trapping capabilities until the depositional slope reaches S/2. Below S/4, the sediment storage will be permanent. Between S/4 and S/2, storage will only be temporary. The length of time this capability exists varies with the size of the SRS. The 125-foot SRS would provide at least temporary storm sediment deposition through the entire 50 years.

Mudflow deposition is likely only in the first few years, until sediment deposition reaches the spillway crest. After that point, the behavior of mudflows is unknown.

All options will have spillways designed to pass a peak discharge of 213,000 cfs, the probable maximum flood, and a design mudflow of 228,000 cfs (75 mcy). However, the storage used by materials from a low probability event would hasten the time at which slopes of S/4 and S/2 occur. Thus large mudflows or storms can be expected to shorten the effective life of all the SRS options under average conditions.

The storage volumes remaining in the 125 foot SRS impoundment area through the project life, assuming average infill, are shown on Figure III-4.

Real Estate Requirements

Real estate requirements have been established to encompass the structure and appurtenant features, construction area, fish facilities, and sediment storage area of each spillway height studied (see Table III-6).

TABLE III-6

REAL ESTATE REQUIREMENTS

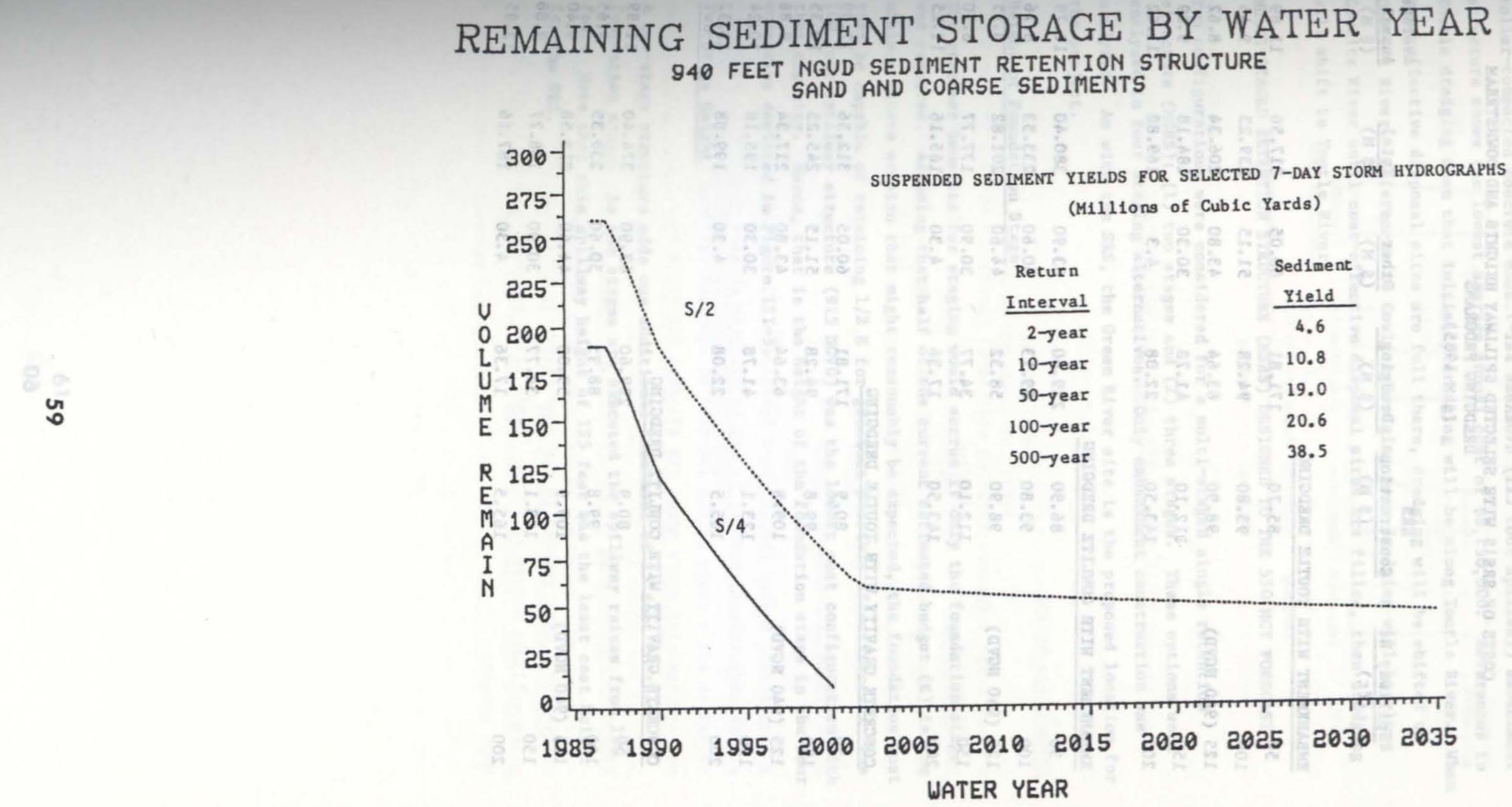
Spillway Height (ft)	Total Project (acres)	Total Real Estate Costs ($M)
50	3,407	$7.7
100	4,607	9.1
125	5,207	9.8
150	5,807	10.5
200	6,407	11.1

Environmental Effects and Mitigation

Water quality downstream from the project could be seriously impacted if water is allowed to be stored during summer and fall. To alleviate this potential problem, the multiple pipe outlets were designed to pass inflow during the warm summer months, minimizing impoundment of the river. After initial dredging, dredging would not be required for 14 years. Hence, the mitigation associated with it would not be necessary until later project years. The most substantial mitigation necessary with an SRS is bypass facilities for migrations of anadromous fish.

Cost Estimates

The total cost estimates in Table III-7 are broken into three categories: 1) Construction; 2) Dredging; and 3) Other. Construction includes the construction costs for the SRS and the related monitoring, real estate, relocation, and mitigation costs. Dredging includes both initial and outyear costs, real estate acquisition costs, and mitigation costs associated with dredging. The other category includes expenditures for rehabilitation of other works impacted by the plan and general monitoring. Detailed breakdowns are reported in Appendix B.



SUSPENDED SEDIMENT YIELDS FOR SELECTED 7-DAY STORM HYDROGRAPHS

(Millions of Cubic Yards)

Return Interval	Sediment Yield
2-year	4.6
10-year	10.8
50-year	19.0
100-year	20.6
500-year	38.5

FIGURE III-4: REMAINING SEDIMENT STORAGE BY WATER YEAR

TABLE III-7
COSTS OF SRS'S WITH SELECTED SPILLWAY HEIGHTS AND DOWNSTREAM DREDGING PROGRAMS
($ M 1985)

Spillway Ht (ft)	SRS Construction ($ M)	Dredging ($ M)	Other ($ M)	Total ($ M)	Average Annual ($ M)
EMBANKMENT WITH TOUTLE DREDGING					
50	85.70	171.81	60.05	317.56	11.89
100	93.80	94.28	51.15	239.23	9.45
125 (940 NGVD)	98.90	63.64	43.80	206.34	8.62
150	112.10	41.78	30.30	184.18	9.09
200	143.50	22.08	4.3	169.88	11.62
EMBANKMENT WITH COWLITZ DREDGING					
50	86.90	229.60	63.90	380.40	11.79
100	93.80	89.13	50.60	233.53	8.76
125 (940 NGVD)	98.90	58.32	44.60	201.82	8.15
150	112.10	34.77	30.90	177.77	8.70
200	143.50	17.36	4.30	165.16	11.25
CONCRETE GRAVITY WITH TOUTLE DREDGING					
50	80.9	171.81	60.05	312.56	12.09
100	99.8	94.28	51.15	245.23	10.35
125 (940 NGVD)	109.8	63.64	43.80	217.34	9.86
150	123.1	41.78	30.30	195.18	10.24
200	165.5	22.08	4.30	199.88	13.32
CONCRETE GRAVITY WITH COWLITZ DREDGING					
50	80.9	229.60	63.90	374.40	11.89
100	99.8	88.95	50.60	239.35	9.65
125 (940 NGVD)	109.9	59.08	44.60	213.58	9.40
150	123.1	34.77	30.90	188.77	9.86
200	165.5	17.36	4.30	187.16	12.95

In general, the embankment structures are less expensive than comparable roller-compacted concrete ones. The 940 NGVD (125 foot spillway) embankment structure shows the lowest average annual cost of $8,150,000. References to Toutle dredging mean that initially dredging will be along Toutle River. When cost-effective disposal sites are full there, dredging will be shifted to Cowlitz River. References to Cowlitz dredging mean dredging will be along Cowlitz River until cost-effective disposal sites are filled, then dredging will shift to Toutle River.

MULTI-STAGED RETENTION STRUCTURE (MSRS) DESIGNED TO THE 550 MCY FORECAST

Two configurations were considered for a multi-staged single retention structure (MSRS): (1) two stages and (2) three stages. These options were analyzed in four staging alternatives. Only embankment construction was analyzed. As with the SRS, the Green River site is the proposed location for the project.

Height of Foundation Stage

The greatest benefits for staging would accrue if only the foundation stage was required. Assuming that half of the current estimated budget (E) is the minimum future erosion that might reasonably be expected, the foundation must then be capable of retaining 1/2 E for greatest possible effectiveness. The 100 foot spillway structure (915 NGVD) was the lowest cost configuration with that capacity. Hence, that is the height of the foundation stage in the four scenarios depicted in Figure III-5.

Two-Stage Height

A two-stage structure adds one additional increment of 25 feet to the foundation stage. As the stages are executed the spillway raises from 100 feet. Note that this spillway height of 125 feet was the least cost height for the SRS.

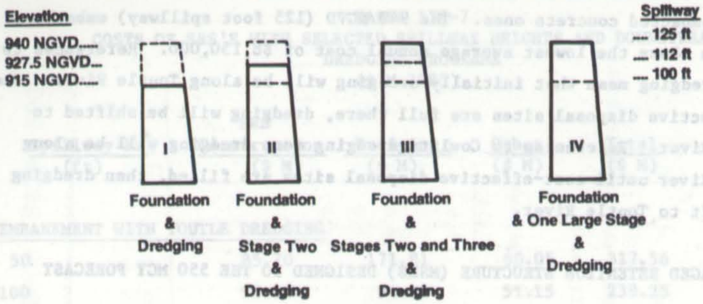


FIGURE III-5: MSRS STAGING SCENARIOS

Three-Stage Height

A three-stage structure adds two additional increments of 12.5 feet to the foundation stage. As the stages are executed, the spillway raises from 100 feet to 112.5 feet, and, finally 125 feet. Rises past 125 feet would call for additional foundation construction and increase costs of the structure.

Height Beyond 125 Feet

Adding stages beyond the 125-foot level were briefly investigated. From preliminary investigations, it may be slightly cheaper (in average annual cost terms) to add a stage to the 150-foot or 200-foot spillway than to incur outyear dredging costs after the 125-foot SRS fills in.

Retention Capabilities

Staging of a MSRS results in the same reservoir retention capabilities for a given spillway height as a SRS. Table III-8 reiterates these values for the MSRS heights.

TABLE III-8
SEDIMENT RETENTION CAPABILITIES WITH STAGING

Spillway Height (ft)	Retention at Spillway Crest (mcy)	At S/4 (mcy)	At S/2 (mcy)
100	25	114	161
112.5	34	129	209
125	45	190	258

Reservoir Area

Reservoir areas are likewise similar to the SRS. Table III-9 reports them with stages.

TABLE III-9
RESERVOIR AREAS OF STAGES

Spillway Height (ft)	Spillway Crest (acres)	Sediment Retention at S/4 (acres)	Sediment Retention at S/2 (acres)
100	510	1500	2510
112.5	680	1800	2880
125	915	2050	3200

Levels of Protection/Low Probability Event Protection

Staging has no effect on permanent levels of protection, assuming increments are executed in proper sequence. If retention, after all stages are in place, is not adequate, downstream dredging will be necessary to maintain protection. If low probability events occur while the reservoirs still have capacity, substantial protection against these events is afforded. Deposits may erode later but will be removed from the event discharge. This protection is renewed as new stages are constructed.

Real Estate Requirements

Real Estate requirements for the SRS alternative have been established to encompass the structure and other appurtenant structures, construction area, fish facilities, and sediment storage area. If staging is authorized, final real estate acquisition will be determined based on the final stage authorized for project purposes.

Environmental Effects and Mitigation

As with the SRS, programs are necessary for migration of fish into the upper Toutle Valley and dredging mitigation in the outyears.

Cost Estimates

With staging, four scenarios are possible: (1) construction of the foundation stage only, resulting in a 100-foot spillway structure; (2) execution of two of the three stages in a three-stage configuration, for a spillway of 112.5 feet operational in 1996; (3) execution of three of three stages, for a 125-foot spillway operational in 2003; and (4) building a 125-foot spillway in two stages to be operational in 1996 (see Figure III-3). Table III-10 depicts the costs for these MSRS possibilities. These dollar estimates were calculated in the same way as for the SRS options.

The least-cost alternative is a two-stage embankment MSRS with both stages executed with dredging in the Cowlitz River first.

LEVEE IMPROVEMENTS

Each of the four lower Cowlitz River communities, Longview, Kelso, Lexington, and Castle Rock, have existing levees (see Figure III-1, p. III-2) affected by levee raise options. Raises could be done at each location, all of them, or any combination of them. Three levels of improvement are considered. The minimum improvements bring current levees up to Corps' standards and only increase height incidental to that action. The second and third options are designated "medium" and "high" raises.

TABLE III-10
COSTS OF MSRS SCENARIOS
($ M 1985)

EMBANKMENT WITH TOUTLE DREDGING

Scenario	Structure	Downstream Dredging	Other	Total	Average Annual
1 (I)	99.80	94.28	51.15	245.23	9.86
2 (II)	100.95	82.96	48.40	232.31	9.53
3 (III)	99.96	69.17	41.20	210.33	9.17
4 (IV)	99.80	66.67	40.20	206.67	8.97

EMBANKMENT WITH COWLITZ DREDGING

Scenario	Structure	Downstream Dredging	Other	Total	Average Annual
1 (I)	99.80	91.01	50.60	241.41	9.16
2 (II)	100.95	79.91	50.80	231.66	8.98
3 (III)	99.96	61.84	44.80	206.60	8.61
4 (IV)	99.80	59.62	43.70	203.12	8.45

Levels of Protection

Levels of protection cannot be attached to levees alone. Without a retention structure or dredging to maintain channel geometry, levels of protection would constantly decrease. They will be reported with the combination plans reviewed later in this chapter.

Real Estate Requirements

All options would require land acquisition with some relocation of businesses or homes. Under the medium or high options, some highway relocation would be required.

Environmental Effects and Mitigation

The levees themselves have little effect on the environment. They exist in places of urban development, hence wildlife habitat is not affected. Even disruptions to human environments are for the most part limited to construction phases of the levees. Some structures would be impacted for all levee raises considered.

Cost Estimate

Table III-11 shows the costs of each of the possible levee measures at each Cowlitz community.

TABLE III-11
COSTS OF LEVEE IMPROVEMENTS
($ M 1985)

	Longview			Kelso		
	Minimal	Medium	High	Minimal	Medium	High
Construction	0	5.40	10.70	0.77	5.40	13.30
Real Estate	0	28.10	28.10	1.10	15.00	15.00
Total	0	33.50	38.80	1.87	20.40	28.30
Avg Annual Costs	0	2.27	2.63	0.14	1.39	1.39

	Lexington			Castle Rock		
	Minimal	Medium	High	Minimal	Medium	High
Construction	0.56	3.20	5.70	0.20	0.35	2.05
Real Estate	0.78	2.00	2.00	0.18	3.65	3.65
Total	1.34	5.20	7.70	0.38	4.00	5.70
Avg Annual Costs	0.10	0.35	0.52	0.03	0.27	0.38

MANAGEMENT STRATEGIES

The measures presented to this point are not necessarily individually viable or optimal strategies as they stand. Combinations of them are among the plan

alternatives directly considered in this report. The plan alternatives include dredging alone, dredging with levee raises, SRS's, MSRS's, and SRS's with levee raises. No MSRS had lower costs than an SRS of the same spillway height, hence MSRS's with levee raises are not evaluated. All of the SRS's and MSRS's under consideration require downstream dredging initially and in the outyears, hence all retention structure strategies are inherently combinations of a structure and dredging. Table III-12 enumerates the alternatives. If they were previously reviewed, the location of that discussion is noted. This section details only those not previously covered.

TABLE III-12
MANAGEMENT STRATEGIES REVIEWED

Strategy	Reviewed in Chapter III at Pages:
1. Base Dredging	III-3 to III-5
2. Intermediate Dredging	III-5 to III-6
3. Maximum Dredging	III-5 to III-6
4. SRS/outyear downstream dredging	III-6 to III-14
5. MSRS/outyear downstream dredging	III-14 to III-17
6. Levee Improvements	III-17 to III-20
7. Base Dredging with Minimum Levee Improvements	III-21 to III-23
8. Base Dredging with Medium Levee Raises	III-22 to III-23
9. Base Dredging with High Levee Raises	III-22 to III-23
10. Intermediate Dredging with Minimum Levee Improvements	III-22 to III-23
11. SRS with Minimum Levee Improvements, Base Initial and Outyear Dredging	III-23 to III-24
12. SRS with Minimum Levee Improvements, Base-Plus Initial and Outyear Dredging	III-24 to III-25

DREDGING/LEVEE IMPROVEMENT COMBINATIONS UNDER THE 550 MCY FORECAST

Ten combinations of dredging with levee raises are reviewed as possible management strategies. Table III-13 shows them. Combinations of intermediate dredging and medium or high levee raises were not considered because of their high costs and limited improvements in protection.

TABLE III-13
LEVEE RAISE/DREDGING MEASURES CONSIDERED

	Levee Raises					
	Minimal				Medium	High
Dredging	KL	KL,LX	KL,CR	KL,LX,CR	KL,LX,CR	KL,LX,CR
Base	X	X	X	X	X	X
Intermediate	X	X	X	X	0	0

LEGEND:

X = Considered
0 = Not Considered

KL = Kelso
LX = Lexington
CR = Castle Rock

Levels of Protection

With minimal improvements and base dredging, Longview has 71-year, Kelso (KL) has 70-year, Lexington (LX) has 125-year, and Castle Rock (CR) has 91-year PSP during the Toutle River dredging period. From 2001, when dredging is in the Cowlitz River, this reduces, respectively, to 71-, 56-, 111-, and 33-year protection. With minimal raises and intermediate dredging, the comparable Toutle dredging numbers are 167-, 143-, 233-, and 133-year PSP; Cowlitz dredging results in 149-, 139-, 192-, and 71-year levels. The medium and high raises, respectively, provide 100- and 500-year protection with base dredging.

Total costs are represented in Table III-14. The average annual costs for these options are reported as part of the economic analysis in Chapter IV. In general, the costs reported in Table III-11, those for the levees themselves, are initial costs. They would be incurred in 1986 and 1987.

TABLE III-14
COSTS OF LEVEE RAISE/DREDGING MEASURES
($ M 1985)

	Levee Raises					
Dredging	Minimal				Medium	High
	KL	KL,LX	KL,CR	KL,LX,CR	KL,LX,CR	KL,LX,CR
Base	348.51	349.85	348.89	350.23	409.74	427.14
Intermediate	478.72	479.34	478.38	479.72	1/	1/

1/ Option not considered.

Reduction Caused by 10-Year Flood

Sediment deposition from large flood events can be expected to cause temporary reductions in the levels of protection. The length of time and the size of the reduction will depend on the magnitude of the flood. A 10-year frequency flood is likely to occur several times during the 50-year project period. If it occurred between 1986 and 2000, it would deposit sediment in the Toutle River sumps and greatly reduce their capacity to handle any subsequent events. Under the base dredging with minimal levee improvement alternative, this would cause the levels of protection at Lexington to fall from 125-year to 111-year and those at Castle Rock to fall from 91-year to 33-year, until the Toutle River sumps were restored to full capacity. This would not cause a noticeable change in the levels of protection at Longview (71-year) or Kelso (70-year) because of the expected Cowlitz deposition pattern (Appendix A). Should a 10-year flood occur after 2000 (when dredging is being done in the Cowlitz River), 3 mcy of deposition would occur in the Cowlitz River, mostly

upstream from RM 5. The result would again be no noticeable reduction in levels of protection at Longview and Kelso, but temporary reductions at Lexington from 111-year to 102-year and at Castle Rock from 33-year to only 13-year protection.

SRS WITH MINIMUM LEVEE IMPROVEMENTS AND OUTYEAR DREDGING FOR BASE CHANNEL GEOMETRY

The 125-foot spillway (940 NGVD) SRS, with associated dredging, was considered in combination with minimal levee improvements at 1) Kelso; 2) Kelso and Lexington; 3) Kelso, Lexington and Castle Rock; and 4) Kelso and Castle Rock. Longview's current levees are considered adequate in this analysis, hence are not improved beyond current levels. Initial and outyear dredging to maintain base condition channel geometry would remove 32 mcy of sediment from the Cowlitz River.

Levels of protection are improved over the 125 foot SRS without levee improvements. Particularly, substantial added protection occurs at Kelso. For example, the 125-foot SRS with levee improvements at Kelso and Castle Rock shows 100-year protection at Longview, 77-year at Kelso, 91-year at Lexington, and 91-year at Castle Rock. Again the SRS maintains the channel against an low probability event as long as it has reservoir capacity.

Costs

Table III-15 shows the total and annual average costs of SRS/dredging/levee improvement alternatives.

TABLE III-15
COSTS OF SRS/LEVEE IMPROVEMENT/DREDGING FOR BASE GEOMETRY STRATEGY
($ M 1985)

Levee Improvements at	Initial Costs	O&M	Other Costs	Total	Average Annual
Kelso	137.79	28.10	37.80	203.69	8.29
Kelso, Lexington	139.13	28.10	37.80	205.03	8.39
Kelso, Castle Rock	138.17	28.10	37.80	204.07	8.32
Kelso, Lexington & Castle Rock	139.51	28.10	37.80	204.07	8.32

SRS WITH MINIMUM LEVEE IMPROVEMENTS AND BASE PLUS DREDGING

Finally, this SRS, levee improvement, and dredging strategy can be done with an increment of dredging beyond what is needed to maintain base channel geometry. This was considered to evaluate the costs (and in Chapter IV, the benefits) of dredging greater volume than base dredging, but less than intermediate dredging. We have termed this level of dredging as base-plus. This plan includes the 125 foot SRS, minimum levee improvement at Kelso, but requires more dredging in the Cowlitz River in intial and outyears. An additional 12 mcy of sediment is removed, for a total of 44 mcy of dredged materials on disposal sites.

Levels of protection are substantially improved by this greater dredging. Longview has 167-year, Kelso 143-year, Lexington 167-year, and Castle Rock 118-year protection with this strategy.

Costs

Table III-16 shows the total and average annual costs for this option. The incremenal cost for the greater dredging averages $1,600,000/yr over those for the SRS/levee improvement/dredging plan which provides protection for base channel geometry only.

TABLE III-16
COSTS OF SRS/LEVEE IMPROVEMENT/BASE-PLUS DREDGING STRATEGY
($M 1985)

Levee Improvements @	Initial Costs	O&M	Other Costs	Total	Average Annual
Kelso	165.16	28.10	37.80	231.06	9.38
Kelso, Lexington	167.01	28.10	37.80	232.91	9.48
Kelso, Castle Rock	166.05	28.10	37.80	231.95	9.41
Kelso, Lexington, and Castle Rock	170.67	28.10	37.80	236.57	9.51

SUMMARY

Costs of all plan alternatives considered here are presented in Table III-17. Levels of protection appear in Table III-18. The most cost-efficient strategy is identified in the next chapter. The possible strategies, however, provide varying levels of protection.

TABLE III-17
COST SUMMARY
($ M 1985)

Alternative	Initial Costs	O&M1/	Other Costs	Total	Average Annual
Base Dredging	276.29	10.20	60.15	346.64	13.08
Intermediate Dredging	403.78	12.20	60.15	476.13	16.50
Maximum Dredging	593.43	15.40	60.15	668.98	22.08
Base Dredging and Min. Levees at:					
KL, LX, CR	279.88	10.20	60.15	350.23	13.35
KL	278.16	10.20	60.15	348.51	13.22
KL,LX	279.50	10.20	60.15	349.85	13.32
KL, CR	278.54	10.20	60.15	348.89	13.25
Intermediate Dredging with Min. Levees at:					
KL,LX,CR	407.37	12.20	60.15	479.72	16.77
KL	405.65	12.20	60.15	478.72	16.64
KL,LX	406.99	12.20	60.15	479.34	16.74
KL,CR	406.03	12.20	60.15	478.38	16.67
Base Dredging & Med. Levees	339.36	10.20	60.15	409.71	17.24
Base Dredging & High Levees	356.76	10.20	60.15	427.11	18.54
SRS/Base Dredging2/ Spillway: 50 ft	291.20	40.40	48.80	380.40	11.79
100 ft	159.70	32.00	41.80	233.50	8.76
125 ft	135.98	28.10	37.80	201.88	8.15
150 ft	129.37	21.60	26.80	177.77	8.70
200 ft	143.46	19.90	1.80	165.16	11.25
MSRS2/, Scenario					
I	173.41	26.20	41.80	241.41	9.16
II	157.66	32.20	41.80	231.66	8.98
III	140.50	29.30	36.80	206.60	8.61
IV	138.12	29.20	35.80	203.12	8.45
125 ft. SRS/Base Dredging1/ w/Levee Improvements at:					
KL, LX, CR	139.51	28.10	37.80	205.41	8.42
KL	137.79	28.10	37.80	203.69	8.29
KL, LX	139.13	28.10	37.80	205.03	8.39
KL,CR	138.17	28.10	37.80	204.07	8.32
125 ft. SRS/Base-Plus Dredging3/ w/Levee Improvements at:					
KL, LX, CR	170.67	28.10	37.80	236.57	9.51
KL	165.16	28.10	37.80	231.06	9.38
KL, LX	167.01	28.10	37.80	232.91	9.48
KL, CR	166.05	28.10	37.80	231.95	9.41

1/ Insignificant for levees. $10,000 to $20,000 per year depending upon length of levee and mechanical equipment incorporated.
2/ Embankment structure with Cowlitz River dredging.
3/ Includes O&M costs for levees.

TABLE III-18
PROTECTION LEVELS
(average exceedance interval in years)

Alternative	Longview	Kelso	Lexington	Castle Rock
1. Base Dredging	71[1]	3	77	71
	(71)[2]	(3)	(59)	(20)
2. Intermediate Dredging	167	11	167	118
	(149)	(10)	(143)	(63)
3. Maximum Dredging	303	56	313	200
	(270)	(50)	(263)	(117)
4. Base Dredging & Min. Levees @:				
KL, LX, CR	71	70	125	91
	(71)	(56)	(111)	(33)
KL	71	70	77	71
	(71)	(56)	(59)	(20)
KL,LX	71	70	125	71
	(71)	(56)	(111)	(20)
KL, CR	71	70	77	91
	(71)	(56)	(59)	(33)
5. Inter. Dredging w/Min. Levees @:				
KL,LX,CR	167	143	233	133
	(149)	(139)	(192)	(71)
KL	167	143	167	118
	(149)	(139)	(143)	
KL,LX	167	143	233	118
	(149)	(139)	(192)	(63)
KL,CR	167	143	167	133
	(149)	(139)	(143)	(71)
6. Base Dredging and Med. Levees	100+	100+	100+	100+
7. Base Dredging and High Levees	500+	500+	500+	500+
8. SRS Base Dredging[3] Spillway: 50 ft, 100 ft, 125 ft, 150 ft, 200 ft	100	4	91	71
9. MSRS[3], Scenario I, II, III, IV	100	4	91	71
10. 125 ft. SRS/Base Dredging[3] w/Levee Improvements at:				
KL, LX, CR	100	77	133	91
KL	100	77	91	71
KL, LX	100	77	133	71
KL, CR	100	77	91	91
11. SRS/Base-Plus Dredging[3] w/Levee Improvements at:				
KL, LX, CR	167	143	233	133
KL	167	143	167	118
KL, LX	167	143	283	118
KL, CR	167	143	167	133

1/ With Toutle River dredging.
2/ With Cowlitz River dredging.
3/ With Cowlitz River outyear dredging.

CHAPTER IV - EVALUATION OF ALTERNATIVES

The purpose of this chapter is to present the economic evaluation of the alternative plans under consideration and identify the national economic development (NED) plan among them. The new sediment forecast results in damage estimates different from those used for comparable analysis in previous documents. Also, the exact set and nature of alternatives has evolved, e.g., current spillway dimensions for an SRS vary from those considered in the Feasibility Report, and, thus, their associated costs are changed. Hence, these figures supercede any given previously and previous NED designations should be put aside.

The NED plan will be considered for sensitivity to possible future departures in sediment yield from the current sediment estimate of 550 mcy over the 50 year project life. All figures presented in this chapter are stated at a 1985 price level using the current Federal interest rate of 8-5/8 percent. Revised safe levee heights were adopted for this report. Temporary emergency protection (TEP) measures in place were not considered in this analysis since these were designed primarily to protect property on a one-time basis. The measures evaluated include dredging, an SRS and an MSRS. Levees require dredging or a SRS to maintain the channel geometry and their effectiveness. For this reason, levees are combined with each of the measures that maintain channel geometry to form alternative plans.

PRODUCTS OF THE BASE CONDITION, ASSUMING THE 550 MCY FORECAST

Damages with No Action

The Feasibility Report contained an estimate of average annual flood damages of $127,504,000 with no action for a period of 50 years commencing in 1984. Using 1985 dollars, the current discount rate of 8-5/8 percent, 1985 safe levee heights and the sediment forecast contained in the Feasibility Report, the value of these damages would be $66,852,000. Using the current 550 mcy sediment forecast, 1985 dollars and safe levee heights, and the 8-5/8 interest rate, the average annual damages with no action are estimated at $43,411,000. Maintaining the base condition at an annual cost of $13,080,000, reduces these residual damages to $16,505,000.

A detailed breakdown of the potential damages is given in Table IV-1. To reiterate, this base action establishes 71-year protection (PSP) at Longview, 3-year at Kelso, 77-year at Lexington, and 71-year at Castle Rock. Benefits for all subsequent management strategies are the difference between the average annual base condition residual damages and the residual damages with the measure being considered (in place).

TABLE IV-1
AVERAGE ANNUAL DAMAGES (AAD) WITH
NO ACTION AND MAINTENANCE OF BASE
($000)

Location	No Action 1/	No Action 2/	Base 2/
Longview (RM 5.5)	$102,109	$ 3,537	$ 180
Kelso (RM 5.5)	6,145	20,693	13,912
Lexington (RM 9.2)	4,002	2,645	273
Castle Rock (RM 17.6)	1,849	1,372	419
Transportation (RM 19.4)	12,233	14,310	132
Unleveed Areas	1,166	854	1,589
TOTAL DAMAGES	$127,504	$43,411	$16,505

1/ As reported in the Feasibility Report. Figured with 1984 dollars, 1984 safe levee heights, and discounted at 8-1/8 percent.

2/ Calculated with 1985 dollars, 1985 safe levee heights, discounted at 8-5/8 percent, and current sediment budget.

Note that once a two-year flood overtops a levee and/or inundates an area, additional damages are not assessed. In the no action scenario, this begins to occur in 1987 at Castle Rock, 1988 at the I-5 and railroad bridges (Cowlitz RM 19.4), 1991 at Lexington, and 1996 at Kelso. Flood inundation becomes so frequent at this point that abandonment is presumed. No costs are included in the average annual damages for abandonment. However, costs for items such as abandonment of utilities, removal or relocation of structures, relocation of residents, and restoration of the abandonment area are sure to occur. While

abandonment is never projected for Longview, regular flooding of commercial, industrial, and residential land proximate to the Cowlitz River could be anticipated with no action.

Products of Base Condition

While no location has less than a 2-year level of safe protection with the maintenance of the base condition, average annual damages of about $14 million can be expected at Kelso. The damages in unleveed areas increase as compared to no action, and the transportation corridor receives $132,000 in average annual damages. In the no action scenario, when flooding is severe enough, the communities are abandoned and no more damages accrue. With base dredging, even though communities and unleveed areas are damaged by floods, it is assumed they are not abandoned and continue to incur periodic damage throughout the 50 year project life. Because of this repeated inundation, damages to the unleveed areas increase when the base condition is maintained. With no action, these areas are abandoned early and no further damages are assessed.

OUTPUTS OF ALTERNATIVES

Dredging Alternatives

Three dredging only alternatives are considered here: (1) maintenance of the base condition, (2) an intermediate level of dredging, 125 percent of the base volume, and (3) maximum dredging, 150 percent of the base volume. Table IV-2 depicts the costs, benefits, and residual damages with the three options.

Of the dredging only alternatives, maintenance of base shows a substantial net benefit compared to no action. However, because of PL 98-63, this level of protection is considered as given. Alternatives can be recommended only insofar as they reduce residual damages beyond those left after implementing the base condition or lower the costs of maintaining the base condition. In this light, there are effectively only two choices here, intermediate and maximum dredging. Of the two, intermediate dredging shows the greater increment of net benefit over base, $7,912,000 to $6,202,000. It also

TABLE IV-2
AVERAGE ANNUAL RESIDUAL DAMAGES AND INCREMENTAL COST OF DREDGING ALTERNATIVES
($000)

Location	Base Dredging 1/	Intermediate Dredging 2/	Maximum Dredging 2/
Longview	$ 180	$ 28	$ 4
Kelso	13,912	3,895	727
Lexington	273	100	31
Castle Rock	419	195	89
Unleveed Areas	1,589	888	417
Transportation	132	67	35
TOTAL RESIDUAL DAMAGES	$ 16,505	$ 5,173	$ 1,303
BENEFITS	NA	11,332 3/	15,202 3/
COSTS	13,080	3,420	9,000
NET BENEFITS	NA	$ 7,912	$ 6,202
BENEFIT/COST RATIO	NA	3.31	1.69

1/ Other alternatives are compared to this base condition. When this level of dredging is compared to the "no action" condition, the benefits are $26,906,000 (BCR is 2.06)

2/ Increment as compared to base dredging

3/ Reduction in residual flood damages from the base condition

provides substantially better levels of flood protection than base maintenance.

Dredging and Levee Raise Alternatives

Levee improvements are considered in this analysis for the four lower Cowlitz River communities: (1) Longview, (2) Kelso (KL), (3) Lexington (LX), and (4) Castle Rock (CR). Four combinations of minimal levee improvements were studied: (1) improvements at three locations (KL, LX, CR); (2) at KL only; (3) at KL and LX; and (4) at KL and CR. The Longview levee is already at Corps of Engineers standards, hence is not included in the minimal improvement actions. These minimal improvement combinations are considered with base and

intermediate dredging. The minimal levee raise is primarily action to bring existing levees to Corps standards. Some low spots will be raised in the process, but general increases in height are not implicit to this minimal option. The minimal rases are expected to be completed by 1987. Medium and high raises with base dredging are also considered. Other combinations of levee raise and dredging were not cost effective. Medium and high levee raises involve general height increases. Although substantial new construction would be necessary for the medium and high options, it was assumed that any levee improvements or raise in Kelso would be completed in 1987. Remaining medium and high raises would come in 1988.

Details on the minimal raises in combination with base dredging are presented in Table IV-3. Table IV-4 shows the incremental costs and benefits for medium and high levee raises over minimal levees. The minimal raises with intermediate dredging are in Table IV-5. Of all the options the greatest net benefits, $12,041,000 per year, are realized through minimal levee raises at Kelso, Lexington, and Castle Rock with base dredging. Again it must be kept in mind here that the average annual costs reported with this option, $270,000, are an increment added to the base dredging costs of $13,080,000. Annual average costs for it compared to no action are $13,350,000. The costs of each levee plan are presented in Table III-11.

One Stage Single Retention Structure (SRS) Alternatives

As detailed in Chapter III, five spillway heights were considered for a SRS, 50, 100, 125, 150, and 200 feet. The details of costs, benefits, and benefit/cost ratios (BCR) for them are presented in Table IV-6. The 125-foot (940 NGVD) option emerges as being both the least costly and having the greatest net benefits. Thus, a SRS with a spillway height of 125 feet at the Green River site and base dredging is the option for further analysis. The economics of that option together with the various combinations of minimal levee improvement, (1) KL, LX, CR, (2) KL, (3) KL, LX, and (4) KL, CR, are reported in Table IV-7. The SRS with downstream dredging to maintain the base channel in outyears and minimal levee improvements at Kelso produce the greatest net benefits of these options, an average of $17,438,000 annually.

TABLE IV-3
RESIDUAL DAMAGES AND INCREMENTAL COST OF LEVEE RAISE ADDED TO BASE DREDGING
($000)

	Minimal Raise at:			
Location	KL,LX,CR	KL	KL,LX	KL,CR
	RESIDUAL DAMAGES			
Longview	180	180	180	180
Kelso	1,846	1,846	1,846	1,846
Lexington	165	273	165	273
Castle Rock	282	419	419	282
Unleveed	1,589	1,589	1,589	1,589
Transportation	132	132	132	132
TOTAL RESIDUAL DAMAGES	4,194	4,439	4,331	4,302
	BENEFITS AND COSTS			
BENEFITS	12,311	12,066	12,174	12,203
COSTS	270	140	240	170
NET BENEFITS	12,041	11,926	11,934	12,033
BCR	45.60	86.19	50.73	71.78

TABLE IV-4
INCREMENTAL COSTS AND BENEFITS OVER THE MINIMAL LEVEES FOR MEDIUM AND HIGH LEVEE RAISES
($000)

	Medium Levee			High Levee		
	Benefits	Costs	Net Benefits	Benefits	Costs	Net Benefits
Longview	66	2,270	- 2,204	152	2,630	-2,478
Kelso	442	1,390	-948	679	1,930	-1,150
Lexington	84	250	-166	126	420	-294
Castle Rock	149	240	-91	242	350	-108

TABLE IV-5
RESIDUAL DAMAGES AND INCREMENTAL COST OF MINIMAL LEVEE RAISES ADDED TO INTERMEDIATE DREDGING
($000)

	Minimal Raises at:			
Location	KL,LX,CR	KL	KL,LX	KL,CR
		RESIDUAL DAMAGES		
Longview	28	28	28	28
Kelso	565	565	565	565
Lexington	59	100	59	100
Castle Rock	183	195	195	183
Unleveed	888	888	888	888
Transportation	67	67	67	67
TOTAL RESIDUAL DAMAGES	1,790	1,843	1,802	1,831
		BENEFITS AND COSTS		
BENEFITS	14,715	14,662	14,703	14,674
COSTS	3,690	3,560	3,660	3,590
NET BENEFITS	11,025	11,102	11,043	11,084
BCR	3.99	4.12	4.02	4.09

TABLE IV-6
AVERAGE ANNUAL BENEFITS AND B/C RATIOS FOR ONE-STAGE RETENTION STRUCTURE ALTERNATIVES
($000)

SRS Alternative (height of spillway in ft)	Damage Reductions	Dredging Savings	Benefits	Costs	Net Benefits	B/C Ratio
50	4,113	13,080	17,193	11,790	5,403	1.46
100	4,113	13,080	17,193	8,760	8,433	1.96
125 (940 NGVD)	4,113	13,080	17,193	8,150	9,043	2.11
150	4,113	13,080	17,193	8,700	8,493	1.98
200	4,113	13,080	17,193	11,250	5,943	1.53

TABLE IV-7
COSTS, BENEFITS, AND RESIDUAL DAMAGES OF A 125-FOOT (940 NGVD) SRS WITH MINIMAL LEVEE RAISES
($000)

Location	SRS only	SRS with KL,LX,CR	SRS with KL	SRS with KL,LX	SRS with KL,CR
			RESIDUAL DAMAGES		
Longview	124	124	124	124	124
Kelso	10,222	1,699	1,699	1,699	1,699
Lexington	227	151	227	151	227
Castle Rock	234	192	234	234	192
Unleveed	1,488	1,488	1,488	1,488	1,488
Transportation	97	97	97	97	97
TOTAL RESIDUAL DAMAGES	12,392	3,751	3,869	3,793	3,827
			BENEFIT AND COSTS		
BENEFITS	4,113	12,754	12,636	12,712	12,678
BENEFITS, incl. foregone costs1/	17,193	25,834	25,716	25,792	25,758
COSTS	8,150	8,420	8,290	8,390	8,320
NET BENEFITS	9,043	17,414	17,426	17,402	17,438
BCR	2.11	3.07	3.10	3.07	3.10

1/ The cost of base dredging, $13,080,000/year

SRS/Minimum Levee Improvements/Base-Plus Dredging

To this point, the 125 foot spillway SRS with minimal levee improvements at Kelso and Castle Rock, and dredging to maintain base condition channel geometry strategy has shown the greatest net benefits. When an increment of dredging beyond that required for maintenance of the base condition is added to this SRS/levee/dredging strategy, minimal levee improvements at Castle Rock no longer produce benefits equivalent to their costs. Therefore, this plan only includes the levee at Kelso. Because this increment of dredging provides substantially increased protection and a consequent increase in benefits, average annual net benefits increase by $924,000. These are reflected in Table IV-8.

TABLE IV-8
COSTS, BENEFITS, AND RESIDUAL DAMAGES OF
A 125 FOOT (940 NGVD) SRS WITH MINIMAL
LEVEE RAISE AT KELSO AND
BASE-PLUS DREDGING
($000)

Location	Residual Damages
Longview	28
Kelso	565
Lexington	100
Castle Rock	195
Unleveed	888
Transportation	67
TOTAL RESIDUAL DAMAGES	1,843
BENEFITS (including foregone costs 1/	27,742
COSTS	9,380
NET BENEFITS	18,362
BCR	2.96

1/ The cost of base dredging, $13,080,000/year.

Multi-Staged Single Retention Structures (MSRS)

The details of costs, benefits, and benefit/cost ratios for the four MSRS scenarios presented in the previous chapter (page III-14 to III-17) are reported in Table IV-9. The last alternative, Scenario IV, shows the greatest net benefits of the MSRS's at $8,743,000 annually. This compares to $9,043,000 for the comparable single stage structure.

The economics of the MSRS with the highest net benefits (IV) are then combined with those of the various levee options and are presented in Table VI-10.

TABLE IV-9
NET BENEFITS AND B/C RATIO OF MSRS ALTERNATIVES
($000)

MSRS Scenario	Damage Reduction	Dredging Savings	Benefits	Costs	Net Benefits	B/C Ratios
I	4,113	13,080	17,193	9,160	8,033	1.88
II	4,113	13,080	17,193	8,980	8,213	1.92
III	4,113	13,080	17,193	8,610	8,583	2.00
IV	4,113	13,080	17,193	8,450	8,743	2.04

Legend:

I = foundation stage only;
II = through stage two of three;
III = three of three; and
IV = two of two.

TABLE IV-10
COSTS, BENEFITS, AND RESIDUAL DAMAGES,
MSRS SPILLWAY HEIGHT 100'→125',
MSRS WITH MINIMAL LEVEE RAISES
($000)

Location	MSRS only	MSRS with KL,LX,CR	MSRS with KL	MSRS with KL,LX	MSRS with KL,CR
			RESIDUAL DAMAGES		
Longview	124	124	124	124	124
Kelso	10,222	1,699	1,699	1,699	1,699
Lexington	227	151	227	151	227
Castle Rock	234	192	234	234	192
Unleveed	1,488	1,488	1,488	1,488	1,488
Transportation	97	97	97	97	97
TOTAL RESIDUAL DAMAGES	12,392	3,751	3,869	3,793	3,827
			BENEFITS AND COSTS		
BENEFITS	4,113	12,754	12,636	12,712	12,678
BENEFITS, incl. foregone costs1/	17,193	25,834	25,716	25,792	25,758
COSTS	8,450	8,720	8,590	8,690	8,620
NET BENEFITS	8,743	17,114	17,126	17,102	17,138
BCR	2.04	2.96	2.99	2.97	2.99

1/ The cost of base dredging, $13,080,000/year.

As shown on Tables IV-6 and IV-9, annual net benefits for the SRS with a 125-foot spillway are greater than for a MSRS with foundation at 100-feet and 25-feet additional for a 125-foot spillway ($9,043,000 and $8,743,000, respectively). Adding minimal levees at Kelso and Castle Rock to the SRS and MSRS (with base condition dredging in outyears) described above increases annual net benefits to $17,438,000 and $17,138,000, respectively. While not shown in a specific table, it should be noted that, if the second MSRS stage construction is completed 11 years after the foundation, average annual costs are the same for both the SRS and MSRS. This is because of the discounted value of the delayed cost for the second stage.

THE NATIONAL ECONOMIC DEVELOPMENT PLAN ASSUMING 550 MCY FORECAST

The best dredging only alternative, intermediate dredging, has net average annual benefits of $7,912,000. The minimal levee raises at Kelso, Lexington, and Castle Rock have $12,041,000 in net benefits. The SRS with base-plus dredging in outyears and a minimum levee raise at Kelso has average annual net benefits of $18,362,000. The MSRS (initial height 100-feet, raised to 125 feet in 1996) with minimal levee raises at Kelso and base-plus dredging provides net benefits of $18,062,000 annually. Table IV-11 provides a comparison of minimal levee raises, the best SRS and MSRS options, and the intermediate dredging option against base dredging. Table IV-12 presents the plans against no action. All comparisons show the NED plan is the 125-foot SRS, with minimal levee improvement at Kelso, and base-plus initial and outyear dredging alternative. Tables IV-13, 14, and 15 display total project costs for the best dredging, SRS and MSRS alternatives.

TABLE IV-11
COMPARISON OF DREDGING, SRS AND MSRS PLANS
(Average Annual $000)

Location	Base w/Min Levees KL,LX,CR 1/	SRS w/Min. Levees KL, CR (Base)	Inter. Dr. w/Min. Levee KL	SRS w/Min. Levees KL (Base-Plus)	MSRS w/Min. Levees KL (Base-Plus)
		RESIDUAL DAMAGES			
Longview	180	124	28	28	28
Kelso	1,846	1,699	565	565	565
Lexington	165	227	100	100	100
Castle Rock	282	192	195	195	195
Unleveed	1,589	1,488	888	888	888
Transportation	132	97	67	67	67
TOTAL RESIDUAL DAMAGES	4,194	3,827	1,843	1,843	1,843
		BENEFITS AND COSTS			
BENEFITS	12,311	12,678	14,662	14,662	14,662
BENEFITS, incl. foregone costs2/	25,391	25,758	27,742	27,742	27,742
COSTS	13,350	8,320	16,640	9,380	9,680
NET BENEFITS	12,041	17,438	11,102	18,362	18,062
BCR	1.90	3.10	1.67	2.96	2.87

1/ Increment for levee raises only. Base dredging costs are assumed and not calculated in costs or benefits.

2/ The cost of base dredging, $13,080,000/year

TABLE IV-12
COMPARISON OF DREDGING, SRS AND MSRS PLANS TO NO ACTION
(Average Annual $000)

Location	Base w/Min Levees KL, LX,CR 1/	SRS w/Min. Levees, LK, CR (Base)	Inter. Dr. w/Min. Levee KL 3/	SRS w/Min. Levee KL (Base-Plus)	MSRS w/Min. Levee KL (Base-Plus)
	RESIDUAL DAMAGES				
Longview	180	124	28	28	28
	(71 yrs)1/	(100 yrs)	(167 yrs)	(167 yrs)	(167 yrs)
Kelso	1,846	1,699	565	565	565
	(70 yrs)	(77 yrs)	(143 yrs)	(143 yrs)	(143 yrs)
Lexington	165	227	100	100	100
	(125 yrs)	(91 yrs)	(167 yrs)	(167 yrs)	(167 yrs)
Castle Rock	282	192	195	195	195
	(91 yrs)	(91 yrs)	(118 yrs)	(118 yrs)	(118 yrs)
Unleveed	1,589	1,488	888	888	888
Transportation	132	97	67	67	67
TOTAL RESIDUAL DAMAGES	4,194	3,827	1,843	1,843	1,843
	BENEFITS AND COSTS				
BENEFITS2/	39,217	39,584	41,568	41,568	41,568
COSTS	13,350	8,320	16,640	9,380	9,680
NET BENEFITS	25,867	31,264	24,928	32,188	31,888
BCR	2.94	4.76	2.50	4.43	4.29

1/ Level of protection provided at safe levee height.

2/ Compared with no action.

TABLE IV-13

DREDGING-BASE CONDITION AND KL/LX/CR MINIMUM LEVEES

TOTAL PROJECT COST

($ millions)

Total Project Cost		
Dredging		276.29
Construction	244.47	
Real Estate	9.15	
Mitigation	22.67	
Levees		5.46
Construction	1.48	
Real Estate	2.06	
O&M	1.92	
Other		70.35
Disposal Site Rehab.	10.20	
Revetments	9.35	
D/S Monitoring	50.80	
TOTAL PROJECT COST		352.10

TABLE IV-14

125-FOOT SRS WITH COWLITZ BASE-PLUS DREDGING AND KL MINIMUM LEVEE

TOTAL PROJECT COST

($ millions)

Total Project Cost		
SRS		98.9
Construction	63.7	
O&M	16.1	
Monitoring	5.2	
Real Estate	12.2	
Relocation	0.4	
Mitigation	1.3	
Dredging		84.8
Construction	76.15	
Real Estate	4.32	
Mitigation	4.33	
Levee (KL Min. Levee)		2.8
Cost	0.74	
Real Estate	1.10	
O&M	0.96	
Other		44.6
Revetment	0.00	
Disposal Site Rehab.	6.80	
D/S Monitoring	37.80	
TOTAL PROJECT COST		231.1

TABLE IV-15

MSRS 100-FOOT TO 125-FOOT WITH COWLITZ DREDGING AND KL MIN LEVEE

TOTAL PROJECT COST

($ millions)

Total Project Cost		
Staged SRS		99.9
Construction	64.6	
O&M	16.1	
Monitoring	5.2	
Real Estate	12.2	
Relocation	0.4	
Mitigation	1.3	
Dredging		89.7
Construction	80.8	
Real Estate	4.4	
Mitigation	4.5	
Levee (KL Min. Raise)		2.8
Cost	0.74	
Real Estate	1.10	
O&M	0.96	
Other		43.7
Revetment	0.00	
Disposal Site Rehab.	7.90	
D/S Monitoring	35.80	
	TOTAL PROJECT COST	236.1

SENSITIVITY OF THE NED PLAN TO SEDIMENT DELIVERY

Because of the dynamic nature of the sediment budget in the Toutle/Cowlitz system, the NED plan was analyzed for sensitivity to increases and decreases in the forecast during the 50-year planning period. Its net benefits were considered if the sediment yield is at the predicted 550 mcy estimate level (E), one-half of the expected number (1/2 E), and one and one-half of the expected number (1-1/2 E), . The conditions that must be accepted in order to expect an E, 1/2 E or 1-1/2 E are discussed in the following section.

Sediment Yield Premises

Premise Set One: If the positions are held that:

1) Volcanic and mudflow activity will remain constant at levels observed since the 1980 eruption.

2) There will be no major lake breakouts.

3) Mudflows will keep stream channels unstable.

4) Large storms will cause major disruptions of the stream channels, cut them deeply, and erode avalanche deposits.

5) Channel incision will exceed 12 feet.

6) Downstream from Coldwater, North Fork Toutle will continue to meander and erode all deposits above the existing stream profile.

7) Only tributary streams will armor during the project life.

8) Natural recovery will not significantly affect erosion.

9) Consultants' recommendations are sound.

10) The 550 mcy of erosion of well-graded material from the debris avalanche would deposit as 640 mcy of poorly-graded material.

Conclusion Set One: The sediment budget expected over the 50-year period is 550 mcy ("E").

Premise Set Two: If the positions are held that:

All premises will be the same as Set One, except:

Volcanic activity will be significantly less than predicted levels, reducing mudflow yields and allowing more channel stability.

OR

All premises will be the same as set one except:

Stream channels will be more stable and large storms will not cause major disruption of the channels.

Conclusion Set Two: The sediment budget expected over the 50-year period would be approximately 1/2 E.

Premise Set Three: If the positions are held that:

All premises will be the same as set one, except:

Volcanic activity will be significantly higher than predicted levels, causing frequent large mudflows.

OR

All premises will be the same as set one, except:

Downstream from Coldwater, North Fork Toutle will erode down to the pre-eruption profile.

Conclusion Set Three: The sediment budget that would be expected over the 50-year period would be approximately 1-1/2 E.

For purposes of this sensitivity analysis, aggregate costs to society include the cost for a measure and the residual damages it allows. Possible measures are compared according to these costs. Three measures are considered here: (1) the SRS, base-plus dredging and levee improvements which comprise the NED, i.e., an embankment structure with a 125-foot spillway and minimal levee improvement at Kelso; (2) base dredging with minimal levee raises at Kelso, Lexington and Castle Rock (this dredging and levee measure was selected for comparison because it has the greatest net benefits among the dredging/levee options); and (3) intermediate dredging with minimal levee improvement at Kelso. This alternative is presented here for purposes of comparison. Although this plan has fewer net benefits than the base dredging-levee plan, it reduces residual flood damages to those equivalent to the SRS alternative.

Table IV-16 reflects the relative societal costs for these options under E, 1-1/2 E, and 1/2 E. The SRS with levees continues to register the least cost under E and 1-1/2 E conditions. However, if 1/2 E proves to pertain in the future, the dredging and levee measures have a lower cost.

TABLE IV-16
AVERAGE ANNUAL COSTS TO SOCIETY OF SELECTED MEASURES WITH E, 1/2 E, AND 1-1/2 E SEDIMENTATION
($M)

	E	1/2 E	1-1/2 E
SRS with 125-foot Spillway with D/S Base-Plus Dredging and Minimal Levee Raise at KL	11.22	9.73	14.91
Base Dredging With Minimal Levee Raise at KL, LX and CR	17.54	8.02	23.95
Intermediate Dredging with Minimal Levee Raise at Kelso	18.48	6.98	28.63

Figure IV-1 shows the best SRS design for each budget; 100' - 1/2 E budget; 125' - E; 150' - 1-1/2 E. Figures IV-2, IV-3 and IV-4 consider the 100-, 125-, and 150-foot spillway SRS's compared to the base dredging alternative and to intermediate dredging, for 1/2 E, E and 1-1/2 E. Figure IV-2 shows that the NED SRS alternative (125-foot) is the least costly when the sediment budget exceeds 0.64 E. All alternatives in these figures contain levee improvements described in Table IV-16.

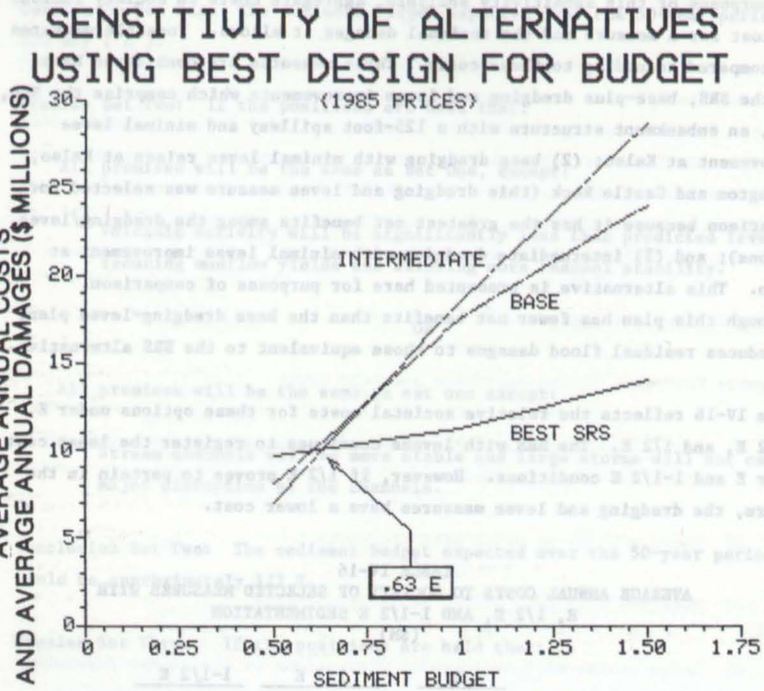


FIGURE IV-1: SENSITIVITY OF ALTERNATIVES USING BEST DESIGN FOR BUDGET (E)

(1985 PRICES)

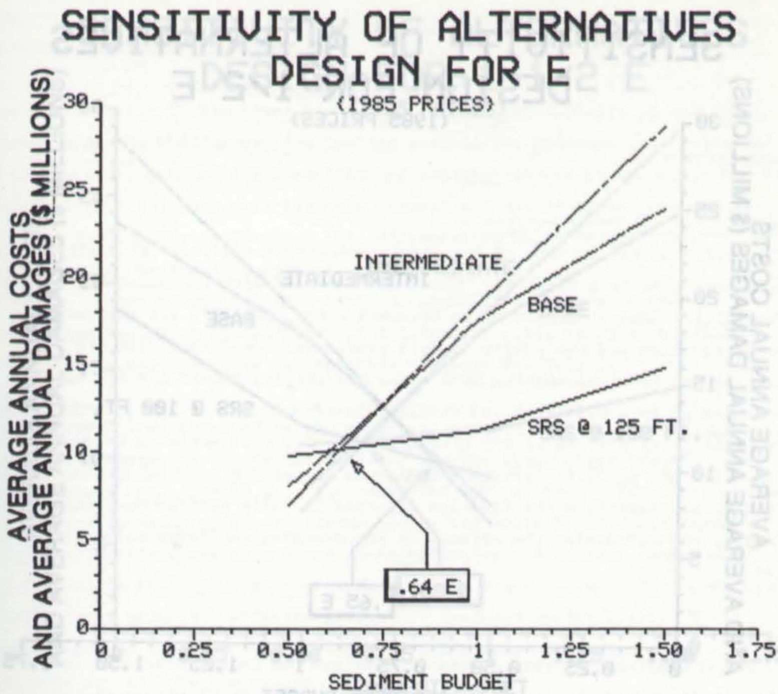


FIGURE IV-2: SENSITIVITY OF ALTERNATIVES DESIGN FOR E
(1985 PRICES)

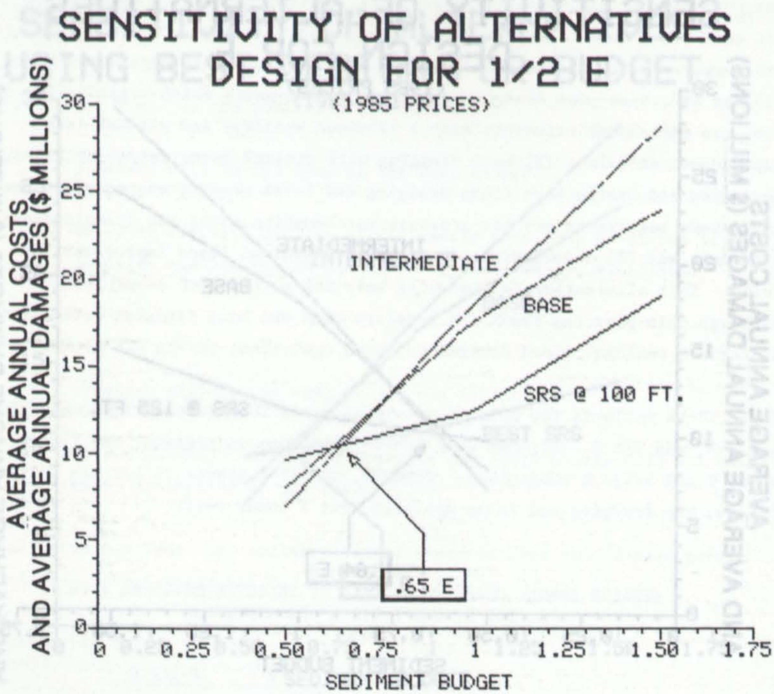


FIGURE IV-3: SENSITIVITY OF ALTERNATIVES DESIGN FOR 1/2 E
(1985 PRICES)

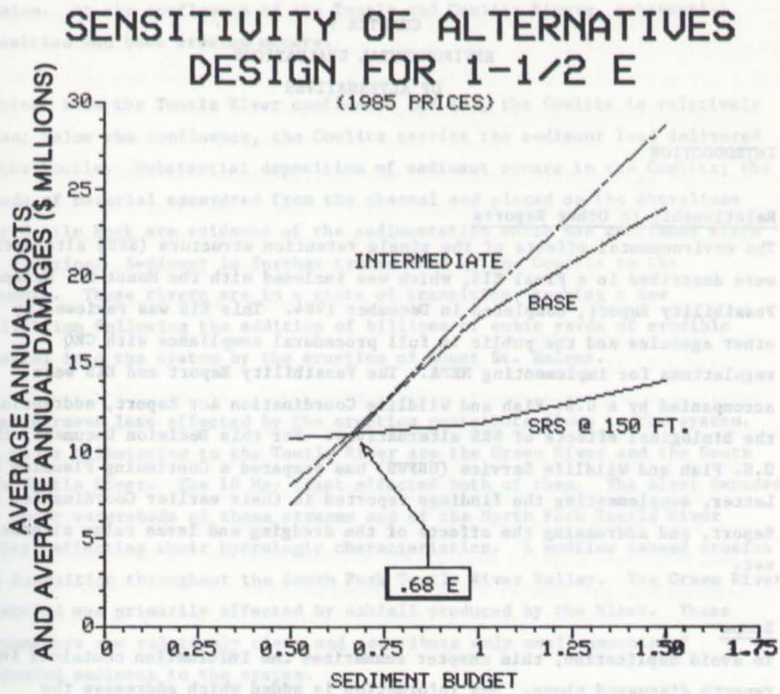


FIGURE IV-4: SENSITIVITY OF ALTERNATIVES DESIGN FOR 1-1/2 E (1985 PRICES)

CHAPTER V

ENVIRONMENTAL EVALUATIONS

OF ALTERNATIVES

INTRODUCTION

Relationship to Other Reports

The environmental effects of the single retention structure (SRS) alternatives were described in a Final EIS, which was included with the Mount St. Helens Feasibility Report, completed in December 1984. This EIS was reviewed by other agencies and the public in full procedural compliance with CEQ regulations for implementing NEPA. The Feasibility Report and EIS were accompanied by a U.S. Fish and Wildlife Coordination Act Report, addressing the biological effects of SRS alternatives. For this Decision Document, the U.S. Fish and Wildlife Service (USFWS) has prepared a Continuing Planning Aid Letter, supplementing the findings reported in their earlier Coordination Act Report, and addressing the effects of the dredging and levee raise alternative set.

Scope

To avoid duplication, this chapter summarized the information contained in the reports discussed above. New information is added which addresses the physical, social and economic effects of the dredging and levee raise alternatives.

AFFECTED ENVIRONMENT

Physical Environment

The North Fork Toutle River has its origins on the northwest slopes of Mount St. Helens. Its upper valley contains massive amounts of material from the debris avalanche released by the 18 May 1980 eruption. Downstream from the debris avalanche, the North Fork courses through the material deposited by mudflows to its confluence with the South Fork, forming the Toutle River. As the gradient of the stream bed decreases in the lower valley, sedimentation increases, causing channel infilling, increased channel widths, and bank

erosion. At the confluence of the Toutle and Cowlitz Rivers, substantial deposition and bank erosion occurs.

Upstream from the Toutle River confluence (RM 20), the Cowlitz is relatively clean; below the confluence, the Cowlitz carries the sediment load delivered by the Toutle. Substantial deposition of sediment occurs in the Cowlitz; the mounds of material excavated from the channel and placed on the shorelines near Castle Rock are evidence of the sedimentation which has continued since the eruption. Sediment is further transported by the Cowlitz to the Columbia. These rivers are in a state of transition, seeking a new equilibrium following the addition of billions of cubic yards of erodible material into the system by the eruption of Mount St. Helens.

Other streams less affected by the eruption contribute flows to the system. The major tributaries to the Toutle River are the Green River and the South Fork Toutle River. The 18 May blast affected both of them. The blast denuded the upper watersheds of these streams and of the North Fork Toutle River Valley, affecting their hydrologic characteristics. A mudflow caused erosion and deposition throughout the South Fork Toutle River Valley. The Green River watershed was primarily affected by ashfall produced by the blast. These streams are now relatively clean and contribute only small amounts of suspended sediment to the system.

The debris avalanche is 17 miles long and over 600 feet deep in some locations. It averages 150 feet deep, tapers down to 10 feet of depth at the toe, and has an overall slope of about 3 percent. The total estimated volume of the avalanche is about 3.8 billion cubic yards. The material in the avalanche varies in size from silts and clays ("fines"), to sand, gravel, cobbles and boulders.

The fine materials are easily eroded and transported, move downstream suspended in the flow and are carried into the Columbia River. Few fines are expected to remain in the Toutle-Cowlitz River system. Medium and fine sand-size material is the major source of sedimentation. Sand is transported through the steeper gradient reaches of the North Fork and Main Stem Toutle Rivers, but as the river gradient becomes less steep and the flow less rapid,

the sand particles deposit, particularly in the lower 20 miles of the Cowlitz River.

Biological Environment: Fisheries

Prior to the eruption, streams in the Cowlitz-Toutle watershed supported anadromous and resident fish populations. Anadromous fish included wild-run and hatchery-produced fall and spring chinook, coho salmon, winter and summer steelhead trout, and sea-run cutthroat trout. Hatcheries accounted for the majority of the anadromous fish production in the basin containing the Cowlitz and Toutle River drainages.

The eruption of Mount St. Helens significantly affected the fishery of this area, although the degree of impact varied by tributary. The existing condition reflects the dynamic condition of a disturbed environment. The fishery, dependent upon the quality and quantity of available habitat, continues to be affected by ongoing sedimentation, while slowly recovering toward the pre-eruptive condition. The Toutle River fishery resource has recovered in the past after prior eruptions of Mount St. Helens; and it is expected to recover through time to a condition similar to that of the pre-eruption state. Any description of the current condition of this resource must, consequently, be viewed as a temporary condition with improvement underway. By river system, the following conditions exist.

Toutle River

The present condition of fish habitat in the Toutle River system varies greatly, depending upon the degree of impact caused by the eruption and extent of continued perturbation. For example, the eruption did not affect Alder Creek (a tributary to the North Fork Toutle upstream from the Green River), and it currently provides productive habitat. At present, these smaller tributaries, such as Alder Creek, provide the major spawning and rearing habitat available in the upper North Fork Toutle. Eventual major production, however, is more closely related to the habitat provided by the larger streams: the North Fork Toutle, South Fork Toutle, and Green River. As described in greater detail in the sediment appendix, the continuing

sedimentation and erosional processes affect these major tributaries to varying degrees. It is projected that the North Fork Toutle will continue, as is currently the case, to experience major sediment deposition from the debris avalanche. This impact and associated channel destabilization will prevent the reestablishment of productive fisheries habitat for some time. The Green River and South Fork Toutle are not experiencing the habitat-limiting impacts of the North Fork Toutle and are showing signs of recovery. However, the lack of riparian vegetation, which provides shading to cool waters to favorable levels, limits fish production. Currently, high stream temperatures, particularly on the Green River, affect production adversely.

The main stem Toutle River continues to experience the effects of habitat-inhibiting sedimentation. Continuing erosion creates a stream where fish must contend with turbidities higher than any stream in America, if not the world; a stream that continuously shifts course and does not allow the reestablishment of mature riparian vegetation; a stream where sediment continues to bury stream gravels. In whole, it is a stream where the continued existence of an anadromous fish run is a tribute to the survival instinct of the species. Throughout the Toutle River Basin, eruption-related events affected about 135 miles (77 percent) of the streams used by anadromous fish. This included all of the larger streams (about 101 miles) and 34 miles (46 percent) of the accessible tributaries. About 62 miles of resident fish habitat were also harmed.

Besides the problems affecting natural anadromous fish production in the basin, hatchery production which adds substantially to overall production from this basin continues to be lost. Mudflows inundated the Toutle Salmon Hatchery as well as the Deer Creek rearing pond. They are currently inoperable. Since hatcheries produced approximately 70 percent of the salmon and 60 percent of the steelhead in this basin, this loss greatly influences eventual production.

Cowlitz River

The Cowlitz River serves primarily as a migratory pathway for anadromous salmon and trout produced in the Toutle and upper Cowlitz systems, although

some rearing and spawning habitat existed prior to the eruption. A large spawning run of smelt continues to use this river.

The Cowlitz River downstream from the Toutle River remains severely affected by the sediment from the Toutle. Spawning gravels once present are buried under several feet of sediment. The sediment delivery to this river reach persists, creating difficult passage conditions. Above the confluence of the Toutle River, the upper Cowlitz is unchanged from the pre-eruptive condition. Pre-eruption anadromous fish hatchery production of the Cowlitz River approximated three times that of the Toutle River basin. With the severe damage that has occurred in the Toutle system, the upper Cowlitz fish now make up the majority of anadromous fish population in the basin.

Hatcheries in the upper Cowlitz River provide the majority of this production. These hatcheries compensate for fish losses associated with the Tacoma City Light dams on the upper Cowlitz. They produce fish at or near maximum capacity to provide a Cowlitz River fishery.

Columbia River

The Columbia River is critically important to the region's anadromous fish populations. It is the major migratory corridor for the region and provides important rearing habitat. While the Columbia continues receiving sediment, the impact of this sand and silt on the fishery resource is unknown. It is believed, however, that the higher turbidity and shoaling from this additional sediment does adversely affect the fisheries resource.

Biological Environment: Wildlife

Existing vegetation and other factors directly influence the reestablishment of wildlife populations. The eruption resulted in varying impacts to the vegetation, and, hence, wildlife populations. Like the fisheries habitat previously described, the status of wildlife habitat is dynamic; recovery is underway.

Toutle River

The eruption severely affected Toutle River wildlife habitat, although the degree of impact varies considerably by area. Mudflows caused loss of riparian vegetation along the lower reaches of the Toutle, while areas nearer the mountain suffered from blast effects which damaged whole forest communities. Currently, channel meandering continues to impede the establishment of riparian vegetation along much of the drainage. Ongoing sedimentation continues to retard recovery within this floodplain corridor. In areas away from this influence, the recovery of wildlife habitat is occurring quite rapidly.

Cowlitz River

This area previously suffered debasement due to numerous residential and commercial developments along its banks prior to the eruption. Mudflow associated with the eruption further degraded this area and the need for disposal areas during emergency dredging operations also reduced the limited wildlife habitat available. Consequently, Cowlitz River wildlife populations remain low.

Columbia River

The lower Columbia River provides valuable wildlife habitat. The riparian/ wetland communities support abundant avian populations including important migratory and wintering waterfowl.

Social and Economic Setting

Population in the study area is concentrated along the lower Cowlitz River, primarily in the incorporated communities of Kelso (11,000), Longview (30,100), and Castle Rock (2,140) (1983 populations), and the unincorporated community of Lexington. Over fifty percent of the population of Cowlitz County lives in Kelso and Longview, on opposite sides of the Cowlitz River.

Land use in Longview consists of valuable high density residential and commercial development within the city limits, with large areas of industrial activity located in the leveed flood plain of the Cowlitz and Columbia Rivers. In Kelso, single family residential is the largest land use, with a small amount of land in commercial use. Castle Rock and Lexington land use is mainly residential; the remaining rural floodplain provides areas for agriculture, dredged material disposal, and for a minor amount of industrial activity.

The Cowlitz Valley is a segment of a major transportation corridor. It contains Interstate Freeway 5, the major route for the vehicular traffic between Portland, Oregon, and Seattle, Washington. The Burlington Northern and Union Pacific railroad tracks carry an estimated 22 trains per day, including freight and AMTRAK passenger trains. The rights-of-way for these transportation modes are vulnerable to damage by flooding where their bridges cross the Toutle River near its confluence with the Cowlitz.

The economy of Cowlitz County is based on manufacturing industries, with the lumber, wood products, and paper products industries the most important. Retail trade, services, and government are the next largest sectors of the economy. The Kelso-Longview area is the largest center of industrial activity and employment in the county.

ENVIRONMENTAL EFFECTS

Physical Environment

Sediment Retention Structure

The single sediment retention structure alternative entails constructing a single (SRS) or multiple stage (MSRS) retention structure on the North Fork Toutle River with enough storage to trap most of the material projected to erode from the debris avalanche. Downstream dredging would be necessary to remove material to achieve the desired Cowlitz channel condition below the site and to remove sediment which passes downstream during SRS construction, and between the years 2000 and 2035 after the structure is full. During the

outyears, 27 mcy of material would be removed from and disposed of along the Cowlitz River. Minor levee improvements at Kelso are part of this alternative.

Sediment retained behind the structure will permanently fill in the existing streambed and floodplain of the North Fork Toutle River. High suspended loads and sediment levels and channel instability would continue for prolonged periods in the sediment impoundment area. Once maximum sediment retention is achieved, channel stability could occur across the plateau of impounded sediment.

Impoundment by the sediment retention structure could lead to water quality problems if the project were allowed to store water during the summer and fall. To alleviate potential water quality problems, the multiple-level pipe outlet was designed to pass inflow during normal flows and to minimize storage during storm events, thus minimizing the impoundment retention times of runoff.

Downstream from the structure, dredging in the lower Toutle River could still continue for a year and decrease as channel stabilization and degredation occurred. With the material from the debris avalanche retained in the upper Toutle Valley, physical and biological recovery of the lower river will occur at a greatly increased rate compared to no action conditions. Beyond approximately the year 2000, dredging of 27 mcy of material would take place in the Cowlitz River.

Dredging and Levee Measures

Implementation of the dredging alternative would result in the transformation of the landscape in the Toutle and Cowlitz valleys. Approximately 134 mcy of material would be dredged between 1986 and 2035 to maintain the base channel configuration. Intermediate dredging would raise the total volume to 167 mcy. Of the base dredging total, 92 mcy would come from the Toutle River and 42 mcy from the Cowlitz River. In later project years, dredged material would replace low-lying agricultural land and other open spaces in the Cowlitz Valley. This transformation will occur over a period of fifty years, with

lands adjacent to the Toutle river being filled first, followed by sites adjacent to the Cowlitz. In some areas, the Cowlitz River could flow through a channel formed of dredged material, with sloping walls up to 70 feet high at the site's full development. The filling of sites farther inland would extend this transformation beyond the limits of the river itself.

Dredging activities in the river generally result in increased turbidity. Since existing turbidity levels are already high as a result of the continuous sediment load being carried from the Toutle, this impact would be minimal. Return waters from disposal areas generally will carry high levels of suspended solids unless provisions are made to contain these waters to allow settling before release to the river. Disposal sites farther from the river generally rely on existing drainages to return excess water to the river. Any sediment carried by these return waters usually settle out in these smaller drainages and can adversely affect their ability to drain the inland areas. Erosion over time from the disposal piles might also deposit material in inland drainages impeding natural flows and possibly cause minor flooding.

Each disposal site will be evaluated, prior to its use, to determine the existing drainage requirements in the area and the measures needed to maintain that drainage. If this question is consistently addressed in each case over the project life, no significant problems with drainage and runoff should occur.

Levee raises require extending the bases of some portions of the levees to establish the required safe heights and side slopes. Filling on the inland side of the levees is implied. The amounts of fill required vary depending on the level of protection provided, with the least amount of fill required for the base level and the maximum amount for the 500-year level.

Biological Environment: Fisheries

Single Retention Structure

Toutle River: The construction of a single retention structure at the Green River location will have the following major impacts on the Toutle River fisheries resource:

1. Blockage of natural fish movement
2. Inundation of spawning and rearing habitat, and
3. Downstream impacts.

A structure of this nature would totally block all natural upstream and downstream migration of anadromous fish. Fish passage facilities are proposed. Providing these facilities would allow the continuing reestablishment of anadromous fish runs into tributaries above the SRS.

The backup of sediment behind the structure will inundate the streambed of the North Fork Toutle with sediment. This inundation would not be significant since this stream is already subjected to sedimentation from the debris avalanche. However, the height of sediment backup will also affect tributaries that were not significantly affected by the eruption. Alder Creek, which currently provides productive spawning and rearing areas, will be inundated.

The blockage of downstream sediment movement by this structure will result in more rapid recovery of fish habitat below the structure; improved conditions will develop on approximately 17 miles of main stem Toutle River and 13.2 miles of North Fork Toutle River. With reduced sediment delivery, materials in the stream below the structure will erode and allow the reestablishment of a gravel-bottomed stream with riparian vegetation supporting fishlife. This forecast of downstream recovery depends upon the quality of water released from the impoundment. The potential exists for impounded water to warm to such an extent that when released, its temperature would be detrimental to fish survival. However, with the minimum water impoundment proposed, it is anticipated that outflow water temperatures will not be significantly different than inflow temperatures. Initial downstream and outyear Cowlitz River dredging is proposed as part of this plan. This operation would, however, be greatly reduced under the SRS alternative.

Cowlitz River: The major factor affecting fish habitat in the Cowlitz River is the continuing sedimentation. This alternative, by reducing the amount of material delivered to the Cowlitz, would result in accelerated recovery for this stream from its mouth to the confluence with the Toutle, approximately 20 miles of stream.

Columbia River: Since no significant sedimentation is expected for the Columbia from blast debris with the most recent forecast, no alternative impacts this river's fish habitat.

Dredging and Levee Measures

Dredging operations in the lower Cowlitz River would have little adverse effect on migratory fish. Higher turbidity levels would occur during dredging, temporarily degrading the already poor water quality conditions in the locality of the dredging operation. The magnitude of the increase in turbidity over existing conditions would not be great, and would not be expected to prevent or impede fish migrations. Timing of the dredging work would be coordinated with state and Federal fisheries agencies to minimize adverse effects on migrating fish. However, dredging the sediment deposition from a low probability event occurring immediately to or during a fish run would have potentially significant adverse effects. Dredging operations would be conducted to provide sufficient channel width and depth for fish passage at all times.

Dredging in the lower Toutle River has a greater potential to adversely affect fish passage. Its shallow channels and lesser stream flows could mean almost constant perturbation of fish movements. An adequate fish passage channel can be provided, however, by diverting the channel away from the excavation area and maintaining minimum depths as prescribed by fishery agencies. Dredging in the lower Toutle has occurred during several winters at LT-1 without seriously affecting fish passage.

Biological Environment: Wildlife

Single Retention Structure

Toutle River: The major effect upon wildlife of this measure is the sediment inundation of wildlife habitat behind a single structure. The Green River site inundation area of 3,267 acres is shown in Figure V-1. The major change would occur in types other than barren or disturbed revegetated; these two types, which comprise approximately half the area that would be inundated,

will experience continued perturbation from sedimentation with or without the project. Once the fill of sediment behind the structure subsides, the area is expected to return to a marsh/riparian habitat. Downstream from the structure, the reduction in sediment would allow the recovery of riparian habitat unaffected by continuous channel change. This area, including the area in the Toutle River flood plain inundated yearly, is approximately 1,770 acres.

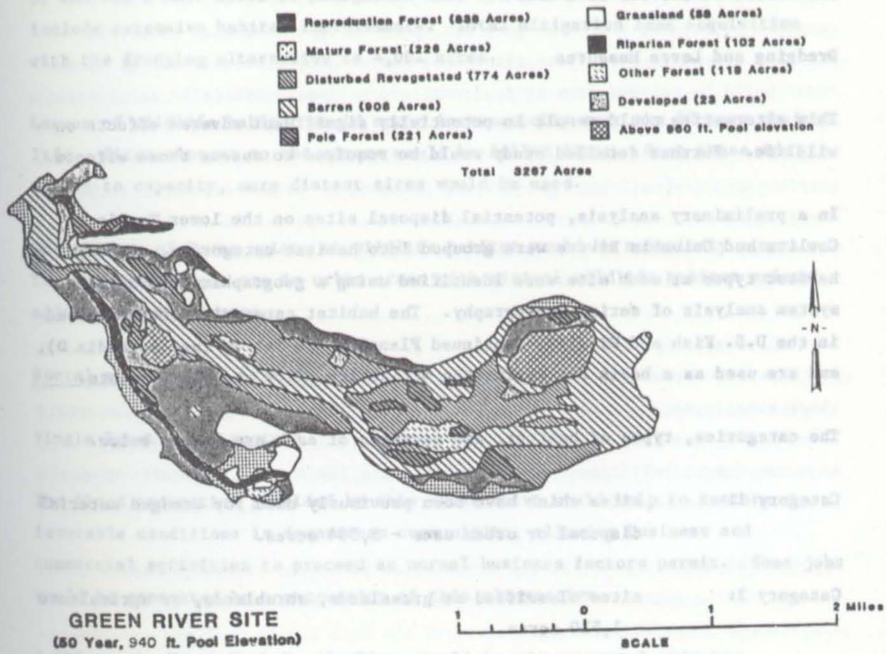


FIGURE V-1. INUNDATION AREA OF GREEN RIVER SITE

Cowlitz River: The reduction of sediment infill and dredging will be beneficial to Cowlitz River wildlife. The reduction in sediment delivery would allow the Cowlitz channel to stabilize and riparian habitat would reestablish sooner than if no action were taken. A reduction in dredging also reduces the amount of wildlife habitat affected by dredged material disposal. In outyears, approximately 32 mcy would be taken from the Cowlitz River with either a SRS or MSRS.

Columbia River: Again with no sediment, no impacts on wildlife habitat can be attributed to the SRS or a MSRS.

Dredging and Levee Measures

This alternative could result in potentially significant adverse effects on wildlife. Further detailed study would be required to assess those effects. In a preliminary analysis, potential disposal sites on the lower Toutle, Cowlitz and Columbia Rivers were grouped into habitat categories. Acreages of habitat types at each site were identified using a geographic information system analysis of aerial photography. The habitat categories are described in the U.S. Fish and Wildlife Continued Planning Aid letter (see Appendix D), and are used as a basis for estimating mitigation costs and requirements. The categories, types of habitat, and acreages of each are listed below.

Category 1: sites which have been previously used for dredged material disposal or urban uses - 3,564 acres.

Category 2: sites classified as grasslands, shrublands, or agriculture - 1,520 acres

Category 3: sites classified as wetlands, forests, or open water - 1,694 acres.

These figures represent the maximum amounts of these habitat categories which could be affected by disposal of dredging material. It is likely that some of

the disposal sites identified in this preliminary analysis would not be available for disposal for one reason or another.

For this analysis, a preliminary estimate of mitigation associated with the dredging alternative was derived. Category 1 sites used for dredged material disposal would not require the acquisition of any lands for mitigation, but will require revegetation. Category 2 sites used would require the acquisition of one acre for each acre of disposal, and revegetation of the disposal and mitigation lands. Category 3 sites would require the acquisition of one and a half acres of mitigation land for each acre of disposal and include extensive habitat improvements. Total mitigation land acquisition with the dredging alternative is 4,061 acres.

Losses of wildlife habitat would occur incrementally over the 50-year project life. Sites closest to the rivers would be filled first. Once these are filled to capacity, more distant sites would be used.

The effects of levee raises on wildlife habitat would be relatively minor. The existing levees are in urban areas with minimal wildlife habitat values adjacent to the levees.

Social and Economic Effects

Single Retention Structure

The flood protection provided by this alternative would help to restore favorable conditions in downstream communities, allowing business and commercial activities to proceed as normal business factors permit. Some jobs would be generated by construction of this alternative.

A SRS on the North Fork Toutle River would inundate several private residences, a state highway, a county road, and utilities. Nine homes or buildings would require removal. Downstream dredging would require use of agricultural and other lands for disposal.

Dredging and Levee Measures

Materials from the dredging alternative would eventually fill most of the low lying areas along the Cowlitz River. Sites close to the river and closest to the reaches in which dredging occurs would be the most desirable from the standpoint of engineering and economics. Many sites adjacent to the river are currently used for disposal and would continue to be used until filled to capacity. Utilizing these sites has the least social and economic effects.

Many other sites, further from the river, were never used for disposal and continue to be used for other purposes, such as agriculture or recreation. Disposal of material on these sites would have a much greater impact. These lands would be removed from agricultural production, potentially eliminating a number of economically viable family farming operations in this area. Other sites which are currently used for recreation would not be available for this purpose once disposal begins. Several of these sites are developed parks; their elimination would result in a substantial loss to the communities in which they are located. The most notable example is Riverside Park in the unincorporated community of Lexington.

Several potential sites are adjacent to schools and are being used. Disposal on these sites would curtail these uses while disposal is occurring, leaving these schools adjacent to disposal piles. The elevation of these areas could be up to 70 feet higher after filling than the ground elevation of the adjacent school buildings. Use of these sites for disposal of sediment would have high human impact.

A number of sites contain public works which will need to be relocated, disrupting the sense of community in these areas and the lives of the individuals forced to move.

Evaluation of the social and economic effects of disposal of dredged material at over 100 sites identified in the Cowlitz Valley is complicated by the 50-year life of the project. Locations identified as disposal sites for this action may not be needed for many years. With these sites essentially committed for use as disposal sites at some future time, options available to

the landowner for use or sale of them are restricted. Assuming that rights of entry, easements, or sales would not occur until the need arose for use of the site for disposal, the landowner would probably be reluctant to invest in improvements to the land or the construction or improvement of structures on the site. Although the owner may wish to sell the site to a private party in the interim, it may be hard to find buyers who would be willing to invest in property identified by the Federal government as a potential dredged material disposal site. If sales occur, prices are likely to be affected by this restriction.

The effects of disposal are cumulative over the 50-year project life. Sites closest to the river would be filled first, creating a channel along the lower twenty miles of the Cowlitz River, with sloping walls up to seventy feet high. As sites farther from the river are used, remaining open spaces will be covered with mounds of sandy materials. In some areas, where open space now predominates, existing roads might pass through valleys of dredged material. These effects are most probable in the Lexington area, which is characterized by clusters of residences surrounded by agricultural lauds.

Once filling is completed, the ultimate use of the disposal sites could be much different than that which exists today or which might otherwise be planned through zoning regulations or comprehensive plans. What will occur is difficult to predict because of the time span involved and the actual height to which any given site might be filled. Sites filled up to the maximum height of 70 feet may not be suitable for agricultural, residential or industrial development.

Levee raises in Kelso, Longview, Castle Rock and Lexington could require the removal of existing residences on or near the levees. The number of relocations required varies with the level of protection provided by the levee raise. Accomplishment of 100-year level protection requires relatively few removals and relocations, while modifying the levees to provide a 500-year level of protection demands extensive relocations and modifications to existing structures, including the Allen Street Bridge between Kelso and Longview.

SUMMARY

Table V-1 compares the environmental effects of the SRS and DLR measures. Any option principally involving dredging has potentially severe negative impacts on the physical, wildlife, social and economic environments. The SRS calls for more mitigation of impacts on fish runs in the upper Toutle Valley, in the form of programs to insure passage up- and downstream of the structure, but accelerates the full recovery of the Toutle River below the dam and the lower Cowlitz River. Additional staging in outyears might avoid dredging and the associated environmental effects. In aggregate, the SRS or a MSRS is the preferred alternative based on environmental effects.

TABLE V-1

COMPARATIVE ENVIRONMENTAL EFFECTS OF SRS AND DREDGING/LEVEE RAISE ALTERNATIVES

	SRS	DREDGING/LEVEE RAISE
PHYSICAL ENVIRONMENT	Material eroded from debris avalanche would be retained in the Toutle Valley. Material would continue to be carried from sources downstream of the structure for 1 year, but less sediment would be transported to the lower Toutle, Cowlitz and Columbia Rivers than if no structure built. An increase in temperature could occur (in excess of 28°C during the summer months or up to 7-9°F above natural during the remainder of the year) due to ponding behind the SRS. Cowlitz River is dredged for 27 mcy between 2000-2035.	Materials would be transported to the lower Toutle, Cowlitz, and Columbia Rivers. Hills of dredged material would replace low-lying agricultural lands and other open spaces. Increased turbidity due to dredging operations. Return waters from disposal areas could carry sediment which could settle in and fill existing upland drainages, causing minor flooding in small waterways. Levee raise would require extending bases of some levees to establish required height and side slopes; fill would vary depending on level of flood protection provided. Toutle and Cowlitz Rivers dredged for 134 mcy total.
BIOLOGICAL ENVIRONMENT: FISHERIES	Fish passage in the Toutle River would be blocked above the structure. Loss of habitat with sedimentation upstream of the structure. Recovery of downstream channel and habitat would be	Dredging in the lower Cowlitz would have little adverse effects on migratory fish, assuming operations could be scheduled to avoid major fish runs. This would be particularly problematical if a low

	SRS	DREDGING/LEVEE RAISE
	accelerated as sedimentation and suspended solids are reduced in lower Toutle, Cowlitz and Columbia Rivers. There would be outyear dredging impacts to a lesser degree only.	probability flood occurred immediately before or during a fish run. Dredging in the lower Toutle would have greater potential to adversely affect fish passage; however, care would be taken to provide an adequate fish passage channel separated from the excavation area. Levee raise would not adversely affect fisheries or wildlife.
BIOLOGICAL ENVIRONMENT: WILDLIFE	Establishment of vegetation upstream of the structure would be delayed until erosion of debris avalanche stabilizes. Riparian habitat in the lower Cowlitz would recover more rapidly than if no structure were built. Less land would be needed for dredged material disposal than under a principally dredging option.	Potentially significant adverse effects to wildlife could result from the disposal of dredged material on as many as 6,778 acres on the lower Toutle, Cowlitz and Columbia Rivers. Habitat values at these sites range from low-value disturbed areas to wetlands, forest, or open water. Habitat losses would occur incrementally over the 50-year project life. Further detailed study would be required to assess the effects of dredging on wildlife. The effects of levee raises would be relatively minor.
SOCIAL AND ECONOMIC EFFECTS	Beneficial effects to community viability and economic stability in	Most of the low-lying areas along the lower Cowlitz River could eventually be filled,

SRS	DREDGING/LEVEE RAISE
downstream communities as flood protection is restored and sediment is retained in upper Toutle Valley. Relocation of residencies upstream of the structure would be required.	including sites currently being used for recreation,agriculture, school athletics, residences and businesses. Over 100 sites in the lower Cowlitz Valley have been identified for use as areas for the 50-year project life. Businesses and residences would be relocated, disrupting the sense of community. Open spaces would be replaced by hills of material up to 70-feet high, which may not be suitable for any kind of future industrial or residential development.

STATUS OF COMPLIANCE OF ALTERNATIVES WITH ENVIRONMENTAL LAWS, REGULATIONS, AND EXECUTIVE ORDERS

National Environmental Policy Act

1. SRS: A Draft and Final EIS were prepared in compliance with this Act, and were circulated for public and agency review and comment. The Final EIS was sent forward by the Chief of Engineers to the Secretary of the Army as part of the Feasibility Report.

2. Dredging and Levee Raise (DLR): If this alternative is selected, a supplement to the Feasibility Report EIS will be required.

Clean Water Act

1. SRS: A water quality evaluation, as required by Section 404(b)(1) of the Act, was prepared and signed by the District Engineer following public

review and comment. This evaluation was included in the Feasibility Report and FEIS sent forward by the Chief of Engineers. Compliance with the Clean Water Act will be accomplished through the provisions of Section 404(r) of the Act.

2. DLR: Section 404 evaluations will be completed as required before disposal occurs at individual sites. State water quality certification will be required.

Coastal Zone Management Act of 1973, As Amended

No action under either of these alternatives would occur within the coastal zones of Washington or Oregon. This Act is not applicable.

Endangered Species Act of 1973, As Amended

1. SRS: The U.S. Fish and Wildlife Service was consulted and a determination was made that no threatened or endangered species would be adversely affected.

2. DLR: Consultation with USFWS would be required for each of the proposed disposal sites.

Fish and Wildlife Coordination Act

1. SRS: The USFWS was consulted in compliance with this Act. A Coordination Act Report, coordinated with other Federal and State resource agencies, was received.

2. DLR: The USFWS was consulted in compliance with this Act. A draft Continuing Planning Aid Letter was received and is included in this Decision Document (see Appendix D).

Marine Protection, Research and Sanctuaries Act of 1972, As Amended

1. SRS: Not applicable.

2. DLR: If dredging needs exceed the availability of disposal sites along the lower Cowlitz and Toutle Rivers, transport of dredged material to

the ocean may be considered. A Section 105 evaluation would be required before ocean disposal could occur.

Preservation of Historical Archeological Data Act of 1974 and National Historic Preservation Act

1. SRS: Full compliance. A cultural resources investigation was completed and concurrence with the findings received from the State Historic Preservation Officer. No adverse effects to cultural resources are anticipated with this alternative.

2. DLR: Cultural resources investigations for most of the proposed disposal sites would be required. Some sites which were used previously have received cultural resources clearances.

Executive Order 11988, Floodplain Management

Implementation of any of the measures except the no-action strategy would help to stabilize hydraulic conditions in the Cowlitz and Toutle Rivers and allow local authorities to develop plans to manage future use of the flood plains. Floodplain lands would be reduced by any of the options including dredging.

Executive Order 11990, Protection of Wetlands

1. SRS: The effects of the SRS on wetlands are discussed in the Feasibility Report EIS, and the Continuing Planning Aid letter (Appendix D). Outyear dredging impacts are much lower than those under DLR.

2. DLR: The effects of dredging on wetlands are discussed in the Continuing Planning Aid Letter which is contained in this Decision Document. Further analysis and discussion would be required in a supplement to the Feasibility Report EIS.

CHAPTER VI - CONSIDERATIONS FOR DECISION MAKING

DISCUSSION

Background for the Decision Document

The current CP&E studies include an analysis of four alternative measures (dredging, SRS, MSRS, and levees) to an equal level of detail. Typically, fewer measures would be addressed during this study phase. The uniqueness of existing conditions in the Cowlitz/Toutle River basin dictates the current approach; specifically, the eruption caused major disturbances in the geology and hydrology of the watershed. The short five-year post eruption period of record has not provided the full range of possible events needed to predict future conditions with a normal degree of analytical precision.

Sediment erosion with deposition is partly responsible for potential flooding in the Cowlitz River. This deposition is highly dependent on storm runoff and volcanic activity. Low probability storms (greater than 20-year frequency) have the potential to move large volumes of sediment (see Table II-3) in a few days. These low probability events could create short term sediment problems, but do not have as significant an effect as mudflows on total projected sediment yields. As discussed in Appendix A, volcanically-caused mudflows not only can provide large volumes of sediment in a few short hours, but they also can disturb the stream channels and result in long-term instability. Volcanic activity and mudflows are expected to result in magnitudes of material similar to the experience of the past five years for the entire 50-year study period, making them a dominant sediment-producing process.

The eruption also altered the hydrology of the watershed by altering vegetation and stream characteristics. A return of the watershed to conditions approximating preeruption conditions in all aspects would need to occur for flood peaks and associated flood risks to be significantly reduced without action.

Principle areas where vegetation is returning are the side slopes of the area between the N-1 structure and the mountain. The material included in the

sediment budget comes not from these side slopes but from the debris avalanche (deposited in the river valley by the original eruption). There is little evidence of natural recovery on the avalanche. The deposition of this material varies - with depths to 600 feet. Erosion channels move back and forth across the avalanche, cutting at the sides of the channel and eroding the material. Some of these channels are over 50 feet deep with little chance of stabilizing this material through revegetation. The small amount of vegetation that would establish on the avalanche would eventually be undermined through the erosion process. The result of the lack of natural recovery has been an increase in the discharge of low probability events. The three Toutle River tributaries, the North Fork, South Fork and Green River, used to have gravel and cobble beds. The riverbeds are now largely sand and gravel. All three tributaries now peak at about the same time (this did not happen prior to the eruption). The result of these hydrologic changes is that the peak discharge for any storm event is higher than it was before 1980, and will remain so over the next 50 years unless significant restoration of the watershed occurs.

The key factors to consider in recommending a solution to potential flooding problems in the affected area are:

economic cost of each measure,
environmental values and impacts,
risks associated with each alternative,
and, uncertainty of future sediment yield.

The economic cost of a measure includes not only the cost of implementing the measure, but also the residual damages that would still occur once the measure is in-place and functioning. The impact that a measure or alternative will have on the environmental resources in the affected area must also be considered. Each alternative has environmental pros and cons. The "risk" of a particular measure or alternative relates not only to the degree of flood protection it provides, but also to the degree to which the measure can handle major influxes of sediment from a low probability storm or mudflow without a significant reduction in protection against subsequent storms in the same water year. The solution chosen should be flexible, or able to be modified in future years, to accomodate the uncertainty of future sediment yield.

Summary of Key Decision Document Conclusions (to this point).

General Discussion. As a result of the sediment analysis, the Corps of Engineers developed a sediment budget of 550 mcy (E) to represent the most likely sediment yield during the 50-year project period. If no future action were to be taken to control the sediment, potential flooding along the Cowlitz River would result in average annual damages (at the expected sediment budget) of $43,411,000 per year. With base condition dredging (authorized by Public Law 98-63), damages have been reduced to $16,505,000 per year. The majority of residual damages with base dredging (84 percent) occur in the Kelso area due to a low section of levee. Ten percent of the damages occur in unleveed areas along the 20-mile course of the Cowlitz River below its confluence with the Toutle River. Three percent occur at Castle Rock; two percent at Lexington; and one percent at Longview and the transportation corridor. No damages are included for navigation disruption on the Columbia River as disruption is not anticipated with the current forecast.

Four measures were evaluated during this study in an attempt to address flood damages. These measures were combined into three feasible alternatives for addressing the flooding problem: Dredging based in the Toutle and Cowlitz Rivers, A Single Stage Retention Structure (SRS) with Toutle and Cowlitz River dredging, and a Multiple Staged Retention Structure (MSRS) with associated dredging. All were combined with levee improvements. These alternatives were compared to find the NED plan using the E budget, and a sensitivity analysis was conducted to determine how the NED plan reacts to changes in the sediment budget projection. In all cases, care was taken to assure that each alternative provided comparable levels of protection and residual damages.

Levels of protection provided by the Cowlitz River channel and levees at Longview, Kelso, Lexington, and Castle Rock have been dramatically changed by the eruption and subsequent natural events and recovery actions. Table VI-1 illustrates this point and shows the protection levels achieved with the alternatives in place. It should be recognized that protection levels for the dredging alternative may be lower at some points in any given water year if low probability events deliver sediment at rates that exceed available dredging capacity.

TABLE VI-1
PROTECTION LEVELS
(average exceedence interval, years)

	Pre-Eruption	Base Dredging w/Exist. Levees	Intermediate Dredging + Levees (KL)	SRS, Base-Plus Dredging Plus Levee (KL)
Longview	100-year 1/	71-year	167-year	167-year
Kelso	100-year 1/	3-year	143-year	143-year
Lexington	less than 2/ 10-year	77-year	167-year	167-year
Castle Rock	greater than 3/ 100-year	71-year	118-year	118-year

1/ Based on Portland District interim letter report, entitled, Drainage District Condition Study on Safe Water Surface Levels, dated May 1978. One-hundred-year PSP is the minimum level which existed. Freeboard of 10 feet (at Longview) and 5 feet (at Kelso) were not incorporated into this protection level determination (i.e. the PSP was probably greater).

2/ Inside toe of levee prior to the 1980 eruption was used as the safe height for PSP determination.

3/ Three-feet below the crest of Castle Rock levee prior to the 1980 eruption was used as the safe levee height and for determination of PSP.

The alternative displaying the greatest net benefits (benefits minus cost expressed in dollars per year) - the NED plan - consisted of:

- an SRS (125-foot spillway crest) at the Green River site
- dredging along the Cowlitz and Toutle Rivers in the first year of construction
- outyear dredging along the Cowlitz River beginning in year 2000

and
- a minimal levee improvement at Kelso.

The analysis conducted to determine the NED plan's sensitivity to changes in projected sediment yield indicated that for a yield of 0.64 E or less, intermediate dredging in the Toutle River initially and then in the Cowlitz River, and minimal levee improvements at Kelso, would be the best economic choice.

If the sediment budget were expected to be less than 0.64 E, the NED plan would consist of anticipatory dredging through the establishment and maintenance of sediment stabilization basins (SSB's) and minimal levee improvements at Kelso. These basins slow the velocity of water by overdredging the channel bottom to create a sump to trap sediment material. Nearly all the material dredged under the 0.64 E budget would be dredged on the Toutle River.

The environmental effects of the alternative plans are also sensitive to sediment delivery, but the effects for the E budget are summarized below.

TABLE VI-2
COMPARISON OF ENVIRONMENTAL EFFECTS
FOR SRS AND DREDGING ALTERNATIVES

SRS/DREDGING/LEVEE	DREDGING/LEVEES
° 5207 acres of land required for SRS and other facilities (3200 acres of which would be impacted by retained sediment)	° N/A
° 1300 acres of land required for inital and outyear dredging	° 4400 total acres of land required for annual dredging
° More rapid recovery of downstream habitat along Toutle River due to reduced sediment movement.	° Recovery of downstream habitat along Toutle River delayed by continued sediment movement
° Natural recovery in reservoir area not effective until reservoir filled.	° N/A
° Natural recovery in disposal areas will occur as sites reach capacity and will be more rapid because 44 mcy would be placed.	° Natural recovery will occur as sites reach capacity and will be slower because 134 mcy would be placed.

SRS/DREDGING/LEVEE	DREDGING/LEVEES
° Natural recovery in levee areas depends on construction period; these are already disturbed areas.	° Natural recovery in levee areas depends on construction period; these are already disturbed areas.
° Increased turbidity each of the 32 years when dredging occurs.	° Increased turbidity each of the 50 years when dredging occurs.
° Possible increased water temperature.	° No effect anticipated.
° Relocation of residents upstream from structure required; businesses and residents in disposal areas must be relocated; open space reduced; increased community viability and stability downstream.	° Businesses and residents in disposal areas must be relocated; open space reduced.
° Fish passage in Toutle River blocked by structure; mitigation required.	° No blockage of fish passage due to dredging (assuming required dredging can be coordinated with annual fish migrations).
° Loss of habitat due to sedimentation upstream from structure.	° Potential for major disruption of fish migration and loss of wildlife habitat due to sediment deposition and dredging following low probability storm or mudflow.
° Recovery of downstream channel and habitat more rapid.	° Recovery of downstream channel and habitat slower.

As the volume of material actually delivered to the waterway requiring dredging is reduced, the impacts of all plans are reduced accordingly. Conversely, an increase in the volume of material deposited also increases the impacts of all plans.

SEDIMENT BUDGET DEVELOPMENT

The 550 mcy erosion forecast presented in Appendix A was used to evaluate the alternatives in this report and is based on two main conditions:

1) Volcanically-caused mudflow activity will continue at 1981-1985 levels for the next 50 years.

2) Hydrologic erosion of sediments will continue beyond the project life until sediment sources have been depleted.

Volcanically-caused mudflows and the resulting erosion is estimated to continue at the observed average rate of 5 mcy per year, removing 250 mcy from the avalanche over the next 50 years. This mudflow activity will keep stream channels upstream from Coldwater Creek unstable, contributing, in part, to an additional 75 mcy of hydrologic erosion. In addition, hydrologic erosion of non-mudflow related sediments is primarily expected to occur downstream from Coldwater Creek. This will result in the erosion of 115 mcy of avalanche and alluvial deposits, for a total of 440 mcy. The above estimates were reviewed by expert consultants and, as a result of their comments following their review, the overall estimate was increased by 25 percent (110 mcy) to 550 mcy. The table below summarizes the sediment budget calculation.

TABLE VI-3

SEDIMENT SOURCES AND VOLUMES

(Based on E Budget)

Source	Sediment Yield (Volume, mcy)	(% of Total 550 mcy Budget)
Mudflow generated	250	45%
Hydrologic erosion upstream from Coldwater Creek (Related in part to mudflow activities)	75	14%
Hydrologic erosion downstream from Coldwater Creek	115	21%
Incorporation of consultants review	110	20%
	550	100%

The sediment forecast was systematically developed, with each element interrelated with the rest. Acceptance of conditions other than those used in developing the E estimate could result in a significant, but indeterminate revision to the sediment forecast. For instance, if the mudflow component were to be reduced significantly, separate studies would be required to determine the hydrologic component of the budget. Of particular concern to this study are conditions which would result in revised sediment forecasts that could change the selection of the preferred solution. The sensitivity analysis results indicate that forecasts of less than 0.64 E or greater than E would alter the NED plan. If sediment yields were less than 0.64 E, dredging could become the NED plan. The sensitivity analysis beginning on page IV-17 summarizes conditions which could lead toward forecasts of 1/2 and 1-1/2 E.

SUMMARY DECISION MATRIX

The summary decision matrix shown as Table VI-4 is provided to assist decision makers who have differing objectives, concerns and premises upon which to assess the likely sediment budget. The sensitivity analysis demonstrates that the NED plan will be different if the sediment budget were to be less than 0.64 E. Because the sediment budget and likely extent of natural recovery can not be known with certainty, decision makers should be aware of the implications of their choice. For example, if the SRS is chosen and the sediment budget proves to be less than 0.64 E, a loss of NED will be realized and a permanent blockage of the Toutle River will have been constructed. On the other hand, if dredging is chosen and the sediment proves to be equal to E, a loss of NED will have occurred and significant amounts of sediment will have to be disposed of along the Cowlitz River. Table VI-4 is designed to highlight all the relevant decision aspects of these choices and situations that may occur. For any selection of an alternative, it is possible to identify the premises that could support such a choice.

TABLE VI-4
SUMMARY CHOICE MATRIX FOR DECISION MAKERS (DM)

	I	II	III	IV	V	VI	VII
If DM believe	Sed. budget will be less than 0.64 E and/or SRS is Env. Less Damaging than Dredging	There is uncertainty in sed. budget, but feel it will be >0.64 E, and if they are uncertain about natural recovery and/or SRS is Env. Less Damaging than Dredging	Sed. budget will be >0.64 E and ≤E and SRS is Env. Less Damaging than Dredging	Sed. budget >E and/or SRS is Env. Less Damaging than Dredging	Sed. budget will be less than (<)0.64 E, and/or Dredging is env. less damaging than SRS	There is uncertainty in sed. budget, but expect it will be <0.64 E and/or They are uncertain about natural recovery, but feel it will be substantial and/or Dredging is env. less damaging than SRS	Sediment budget will exceed 0.64 E and/or They believe watershed will return to pre-eruption hydrology and/or Dredging is env. less damaging than SRS
If DM wish to	Assure certainty offered by SRS solution and/or Minimize risk from low probability single or sequential events and/or Emphasize EQ	Assure certainty offered by SRS solution	Assure certainty offered by SRS solution and/or Maximize NED and EQ elements	Assure certainty offered by SRS solution and/or Maximize NED and EQ elements	Maximize NED and/or Emphasize EQ	Maintain greater flexibility to adjust plan to the sed. realized over time	Maintain greater flexibility to adjust plan to the sed. realized over time Choose env. best solution
If DM are willing to	Forego NED for EQ and/or Forego NED for risk aversion Forego opportunity to adjust response to realized sediment Risk financial loss of NED if Sed.<0.64 E Minor dredge in outyears Budget for larger outlay in initial years.	Risk financial loss of NED if Sed.<0.64 E Dredge or build stages(s) in outyears Budget for larger outlay in initial years.	Risk financial loss of NED if Sed.<0.64 E Dredge or build stage(s) in out-years Budget for larger outlay in initial years.	Risk financial loss of NED if Sed.<0.64 E Dredge or build stage(s) in out-years Budget for larger outlay in initial years.	Risk temporarily reduced levels of protection from low probability single or sequential events Forego certainty of SRS solution Risk financial loss of NED if sed. >0.64 E Commit to long-term management of a dredging program Commit to budgeting for dredging costs on an annual basis	Risk temporarily reduced levels of protection from low probability single or sequential events Forego certainty of SRS solution Risk financial loss of NED if sed. >0.64 E Commit to long-term management of a dredging program Commit to budgeting for dredging costs on an annual basis Delay decision on SRS with possibility for construction of SRS at later date	Risk temporarily reduced levels of protection from low probability single or sequential events Forego certainty of SRS solution Accept financial loss of NED Commit to long-term management of a dredging program Commit to budgeting for dredging costs on an annual basis Delay decision on SRS with possibility for construction of SRS at later date
DM would select	125-Foot SRS	125-Foot SRS	125-Foot SRS	125-Foot SRS and Plan for and build a second stage above 125' in outyears or a 150-Foot SRS	Dredging	Dredging	Dredging

CHAPTER VII - RECOMMENDED PLAN OF THE DISTRICT ENGINEER

CONCLUSIONS

The objective of this study was to identify the best plan to reduce flood damages to an acceptable level in accordance with guidance from Principles and Guidelines and sound professional judgment. Identification of the sediment budget to be used for plan formulation is the key to the decision process. Given the uncertainties, 550 mcy represents our best professional analysis of what the sediment budget should be. Based upon the expected sediment budget and the considerations in Chapter VI, I conclude that:

1. The potential for flooding in communities along the Cowlitz River and damage to the transportation corridor require implementation of permanent measures to manage the risk created by the movement of sediment in Toutle and Cowlitz Rivers.

2. Based on the analysis performed during this study, a plan consisting of a single retention structure on North Fork Toutle River at the Green River site, minimal levee improvements at Kelso and supplemental downstream dredging best meet the objective of developing a long-term plan to deal with flood problems resulting from the Mount St. Helens eruption. This plan also achieves the highest economic efficiency consistent with preservation of life and property and effectively deals with variations in quantities of sediment delivery. Minimum levee improvements may be accomplished under authority of PL 98-63.

3. This recommended plan provides more flexibility and safety in managing the unique sedimentation and flooding problem presented by the Mount St. Helens eruption than a dredging only or dredging and minimal levee raise strategy.

4. What we now know about the sediment budget, as presented in this report, shows a need to construct a permanent solution.

5. Coordination with nationwide experts in the field of sedimentation indicates that reported sediment predictions reflect the experience of the last five years and represent the best estimate to be made at this time. Because of the uncertainties associated with volcanic and hydrologic events, we will continue to monitor sediment movement to learn more about sediment deposition over time and the associated risks.

6. The Congress has established a Federal role in flood damage reduction. However, the flood problems stemming from the after-effects of the Mount St. Helens eruption created a unique situation. Past Federal emergency efforts, the Presidential commitment to respond to any future life or property threatening emergency and to prepare a Comprehensive Plan, and passage of PL 98-63 and PL 99-88 all attest to the concern with the flood threat along the Cowlitz and Toutle rivers.

7. Study of the expected sediment budget and application of the choice matrix presented in Chapter VI leads me to conclude that the selection of alternative III, a 125-foot SRS, is the best plan to meet the stated objective. In Chapter IV, this SRS with base-plus dredging during 1986 and between years 2000 and 2035, and a levee improvement at Kelso was identified as the NED plan.

8. A single retention structure on the North Fork Toutle River at the Green River site will impede fish passage into the upper Toutle above the structure. Initial design and construction includes facilities for fish passage using trap and hauling methods.

9. Requirements for annual sediment removal by downstream dredging during later project years will be analyzed each year. A comparison of the cost of this dredging versus raising the retention structure should be undertaken. To this end, no provisions should be made initially to preclude raising a completed structure above the preferred height if future conditions warrant. PL 99-88, which authorizes the Single Retention Structure with downstream action, is flexible enough to allow for raising of the structure if that proves more economical than outyear dredging.

OVERVIEW

The NED plan is a combination of three measures: the 125-foot spillway SRS at the Green River site, minimal levee improvement at Kelso, Washington, and downstream dredging both during construction and with reservoir infill in later project years. The Principles and Guidelines used for Federal studies require designation of the NED plan as the preferred one unless overwhelming evidence justifies another selection. All the evidence supports this plan. It provides the greatest net benefits. It requires limited environmental mitigation. Finally, it provides flexibility to deal with uncertainties about sediment volumes and transportation.

During public and agency review of the Comprehensive Plan and Feasibility Report, Washington State, local governments, and various agencies supported an SRS upstream of the Green River confluence of the North Fork Toutle River. It was viewed as causing minimum impact to the fishery, land use, and residents. This recommended plan would fulfill the desire of these important groups.

RECOMMENDED PLAN ELEMENTS

The SRS

Description

The design and construction methods employed for this structure reflect normal Corps' dam design criteria and will address safety and operational characteristics. The SRS would be constructed of earth and rockfill materials with a right abutment spillway in rock (see Figure VII-1). It would trap sediment and debris while allowing water to pass through an outlet works or over a spillway. When completed, the structure would rise 227 feet above foundation grade, or 182 feet above the existing ground, and extend 1,680 feet in length with a spillway 500 feet wide.

The first feature constructed under the plan would be a large cofferdam upstream from the structure site and the right abutment outlet works. The cofferdam would serve two purposes: (1) to divert river flows around the

FIGURE VII-1: EMBANKMENT SRS

worksite; and (2) to serve as a small interim sediment retention structure. Retention of sediment behind the cofferdam at the earliest possible date will significantly reduce early year downstream actions. Once the main structure embankment is constructed to a functional elevation higher than the cofferdam, the cofferdam will be incorporated either into the embankment or the impoundment area behind the main structure.

The main spillway would be built 125 feet above the existing streambed. Given normal hydrologic conditions, this height will provide capacity adequate to capture most problem-causing sediment anticipated to erode from the debris avalanche between 1987 and 2035. Using the unregulated outlet works in the structure permits a natural variation of the size and depth of the pool extending upstream behind the structure for retaining sediment produced during various storm events. During major storms, large pools would form, allowing material to settle out prior to reaching the structure and outlet works and thereby increasing the actual retention capability of the structure. The structure in its present design not only retains sediment but also provides some initial flow control through the outlet works and later with the spillway. However, flow control declines over time as the pool fills and is considered incidental to the structure. No benefits are claimed.

The structure was tested for both the 213,000 cfs Probable Maximum Flood (PMF) and the 75 mcy Operating Basis Mudflow (OBM) to compare with- and without-project conditions. The flood will be passed and the mudflow either contained or passed without causing greater than without-project damage for the 50-year operational life. In addition, the sediment delivered by a 100-year flood would be trapped until 1991.

<u>Preliminary Design of the Structure:</u> Continued analysis of the SRS site indicates the foundation is composed of competent basalt and dense gravels, indicating adequate support is available for the proposed structure. All studies were made to satisfy existing Corps' design standards.

<u>Sizing of the Spillway:</u> Under normal conditions, a spillway is sized to pass the PMF. However, given the instability of the upper Toutle River Basin and the necessity for providing the greatest possible margin of safety, the

spillway for the retention structure is sized to pass the OBM. The design assumes that Spirit Lake and other upper basin lakes are stabilized. Therefore, hypothetical lake breakouts were not used as a basis for sizing the spillway. Table VII-1 shows the peak discharges at the SRS site for normal annual flows, low frequency floods, the probable maximum flood and the operating basis mudflow.

TABLE VII-1
PEAK DISCHARGES FOR NORMAL AND POSSIBLE FLOWS
AT GREEN RIVER SRS LOCATION

Type of Flow	Peak Discharge (cfs)
Mean Daily Flow	1,254
2-Year Flood	13,100
10-Year Flood	19,600
50-Year Flood	26,100
100-Year Flood	30,800
500-Year Flood	43,000
Probable Maximum Flood (PMF)	206,000
Operating Basis Mudflow (OBM)	228,000

As Table VII-1 indicates, the peak discharge for the PMF is 206,000 cfs and peak discharge for the OBM is 228,000 cfs. Therefore, the OBM is the design flow for the spillway.

As sediment infills behind the structure, available storage is ultimately decreased to a run of river configuration. A determination for an additional height of structure and spillway crest may be required to continue storage. This would substitute for dredging in out years.

Levee Improvements

Description

The safe height of the existing levee at Kelso will be raised through improvements to the oversteepened backslopes. Improvements would bring the levee, which runs from Cowlitz RM 1.3 to RM 7 (see Figure VII-2), up to Corps' standards. The emergency levee structures, constructed in 1982, would be removed as necessary from the existing permanent levees to allow construction of the improvements. Deficient levee sections would then be improved by adding fill to the overly steep landward slopes, revetting riverward slopes where required, and seeding the new fill embankments.

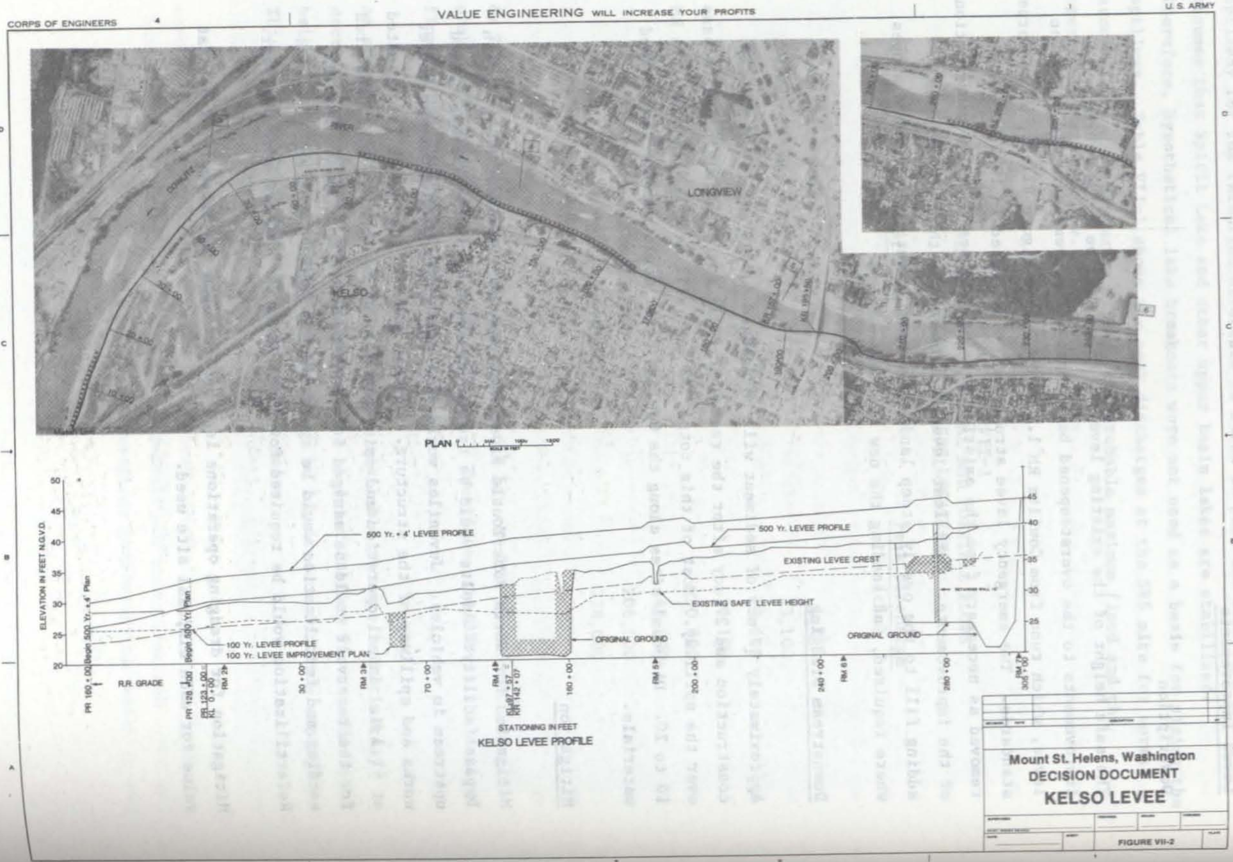
Downstream Dredging

Approximately 17 mcy of sediment will be dredged during the first year of construction and 27 mcy after the reservoir fills and materials begin to pass over the spillway. Most of this total, 32 mcy, will be taken from Cowlitz RM 10 to 20. Disposal sites along the Cowlitz River would receive the dredged materials.

Mitigation

Mitigation for North Fork Toutle River fish runs will be provided by a fish bypass facility. Adults would be trapped at the foot of the SRS and hauled upstream in vehicles. Juveniles would pass downstream throughout the outlet works and spillway of the structure. Initial cost of the bypass is estimated at $1.3 M. Annual operation and maintenance would be $0.1 M. Lands acquired for the reservoir would be managed for wildlife habitat. Limited initial seeding and fertilization would be approximately $1,000 per acre. Refertilization would be required for three years at $500 per acre per year.

Mitigation for dredging operations is dependent upon the category of habitat value for each disposal site used.


CORPS OF ENGINEERS
VALUE ENGINEERING WILL INCREASE YOUR PROFITS
U.S. ARMY
LONGVIEW
KELSO
COWLITZ
RIVER
PLAN
ELEVATION IN FEET N.G.V.D.
500 Yr. + 4' LEVEE PROFILE
500 Yr. LEVEE PROFILE
EXISTING LEVEE CREST
EXISTING SAFE LEVEE HEIGHT
ORIGINAL GROUND
100 Yr. LEVEE PROFILE
100 Yr. LEVEE IMPROVEMENT PLAN
R.R. GRADE
STATIONING IN FEET
KELSO LEVEE PROFILE
Mount St. Helens, Washington
DECISION DOCUMENT
KELSO LEVEE
FIGURE VII-2

Category 1 sites are wetlands and other high value lands. Mitigation for this category would consist of replacement land purchase and habitat enhancement at $4,500 per acre and reshaping and revegetation of disposal sites at an additional $3,000 per acre.

Category 2 sites are not as highly valued as habitat. Mitigation for selection and use of these sites would be some mitigation land purchase revegetation at $3,000 per acre.

Category 3 sites require no mitigation land acquisition, but disposal sites would require revegetation at $3,000 per acre.

Levee construction would require no separate mitigation because the existing levees are already low value habitat. It is expected, however, that surfaces of the levee that are not riprapped would be seeded for erosion control.

With the recommended SRS (NED) plan in place and Cowlitz River outyear dredging, damage of $10,600,000 would not be incurred at the transportation corridor until a flood of approximately 500-year recurrence interval occurs.

REAL ESTATE

The SRS requires 5,207 acres of land above the North Fork Toutle RM 13.0 for the structure and reservoir based on the 125-foot spillway height. Dredging requires approximatey 25 different disposal sites for a total of approximately 1,300 acres. Small amounts of land are required for the levee improvements which will require additional sponsorship.

COST ESTIMATE

Table VII-2 shows the costs of this plan. The expenditures for the SRS, levees, and dredging are detailed. This program will cost $231.1 million in 1985 dollars. Construction of the SRS, fish bypass, and levees accounts for

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$65.7 million of those costs. Initial dredging accounts for another $25.4 million and real estate and relocations are $18 million. Other costs, including O&M, monitoring, and outyear dredging total $122 million.

ECONOMIC SUMMARY

The net benefits of this plan are $18,362,000 annually. This is the most beneficial program with the 550 mcy sediment budget and for modeled sediment deliveries above 350 mcy. Average annual costs for this program are $9.38 million compared to $13.35 million for the best combination of dredging/levee raise measures.

ENVIRONMENTAL SUMMARY

The recommended plan is environmentally advantageous to plans maintaining channel geometry solely by dredging. Potentially substantial impacts of extensive dredged material disposal sites are minimized. Mitigation of fish runs can be carried out by standard programs. Flood control without major land use, social, and economic disruptions to local residents are possible with this plan.

LOCAL SPONSORSHIP

The State of Washington, Cowlitz County, and other local interests have contributed to Federal emergency actions since the eruption. In addition to maintaining the Cowlitz County Flood Warning System, the state has spent $1 million to procure disposal sites for dredged material and another $3.5 million (State Senate Bill 3519) was expended for related activities. For example, the state acquired lands at the Lower Toutle sediment stabilization basins LT-1 and LT-3, where dredging is continuing. After erosion threatened the abutments of the I-5 bridge, the State of Washington Department of Transportation placed revetment and sheet pile at the bridge to prevent further damage and possible closure of this major transportation route.

TABLE VII-2

TOTAL PROJECT COST

125-FOOT SRS WITH COWLITZ BASE-PLUS DREDGING AND KL MINIMUM LEVEE

($000,000)

Total Project Cost		
SRS		98.9
Construction	63.7	
O&M	16.1	
Monitoring	5.2	
Real Estate	12.2	
Relocation	0.4	
Mitigation	1.3	
Dredging		84.8
Construction	76.15	
Real Estate	4.32	
Mitigation	4.33	
Levee (KL Min. Levee)		2.8
Cost	0.74	
Real Estate	1.10	
O&M	0.96	
Other		44.6
Revetment	0.00	
Disposal Site Rehab.	6.80	
D/S Monitoring	37.80	
TOTAL PROJECT COST		231.1

Within Cowlitz County, local sponsors signed cooperative agreements to provide lands, easements and rights-of-way for emergency levee raising. To date, the local governments have expended approximately $7.4 million on activities resulting from the eruption of Mount St. Helens.

The State of Washington and Cowlitz County have indicated their willingness to share in the cost of a solution to the potential flood problem by setting aside $12.9 million and $4 million, respectively, toward the local share of project costs.

RECOMMENDATION

This decision document has been prepared to satisfy the recommendations that the Chief of Engineers forwarded to the Assistant Secretary of the Army in the draft legislation which accompanied his 7 May 1985 submittal of the Mount St. Helens Feasibility Report. The purpose of the continuing studies is to insure that the best solution is ultimately selected for implementation. After carefully considering the uncertainties associated with estimating volume, movement, and deposition of sediment moving in the Toutle and Cowlitz Rivers and after evaluating the environmental, social, and economic impacts of measures for controlling Mount St. Helens sediments, I find no compelling or convincing new evidence to justify selection of a staged sediment retention structure or dredging alternative. Therefore, based upon the preceding analysis, I recommend that the Acting Assistant Secretary of the Army for Civil Works implement the construction of a sediment retention structure, with a 125-foot spillway height, on the North Fork Toutle River with associated downstream dredging and implement improvements to the levee at Kelso, Washington.

GARY R. LORD
Colonel, Corps of Engineers
District Engineer

APPENDIX A

MOUNT ST. HELENS

Sedimentation Study/1985

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INTRODUCTION

Purpose

This appendix updates the 1985 long range sediment forecast for the Toutle-Cowlitz-Columbia river system and documents the rational behind that forecast. The sediment forecast is the basis for planning and designing of permanent sediment control measures.

Sediment Forecast Summary

This 1985 study is the third in a series of long term sediment forecasts made by the Corps of Engineers (COE) for the Toutle, Cowlitz and Columbia Rivers. It is based on a larger data base and more detailed analyses than earlier forecasts. The expanded data base includes 4 photogrammetric surveys of the avalanche, an additional one-and-one-half years of suspended-sediment data, five additional Cowlitz River surveys, and more information on the unit weight and gradation of the materials.

The composition, erosion, and geomorphic development of the debris avalanche was analyzed to determine existing erosion rates and the availability of the sediment sources. Suspended-sediment records and cross-section surveys on the Toutle River were used to determine its role in the sedimentation process. Suspended-sediment records, cross-section surveys, dredging records and bed material samples were analyzed to determine the responses of the Cowlitz and Columbia rivers to observed sediment inflows. The principle conclusions of this forecast are summarized below and described in detail in Sections 2 and 3.

1. Avalanche erosion is estimated to be 23 million cubic yards (mcy) in water year (WY) 1986, declining to about 13 mcy by WY 2000 and to slightly more than 6 mcy in WY 2035. This would result in approximately 630 mcy of erosion between 1980 and 2035 (80 mcy 1980-1985 and 550 mcy 1986-2035).

2. The Toutle River would only be a minor sediment source.

3. Cowlitz River deposition is forecast to reach nearly 120 mcy by 2035, with 80 percent of that volume upstream of River Mile (RM) 10.

4. Deposition in the Columbia River will be minimal and is not expected to be a significant problem except under extreme hydrologic or mudflow conditions.

Previous Sediment Forecasts

Comprehensive Plan

The first sediment forecast was presented in "A Comprehensive Plan for Responding to the Long-Term Threat Created by the Eruption of Mount St. Helens, Washington" (COE, 1983). That forecast was based on a very limited amount of suspended-sediment measurements and avalanche cross-sections. Predicted erosion was based on the observed rate of erosion, and a theoretical equilibrium profile and channel geometry in the avalanche. Cowlitz River deposition was estimated from sediment transport modeling using the COE's HEC-6 computer program "Scour and Deposition in Rivers and Reservoirs". A mass balance was then used to estimate scour and deposition in the remainder of the system. The principle conclusions of the Comprehensive Plan sediment forecast were:

1. Sediment erosion from the avalanche would average 50 mcy cubic yards (mcy) per year for the initial 10 years and would total 1 bcy over 50 years.

2. The Toutle River system acted as a depositional area in the early years and later became a sediment source.

3. Cowlitz River deposition would reach a maximum accumulation of 50 mcy by 1990 and then erode slowly.

4. A total of 240 mcy would have to be dredged from the Columbia River to maintain the navigation channel.

Sedimentation Study/1984

In September 1984, the COE prepared a second long-term sediment forecast report "Mt. St. Helens, Cowlitz and Toutle Rivers, Sedimentation Study/1984" (SS/84). This report was the basis for planning the sediment control measures contained in the "Mount St. Helens, Washington Feasibility Report" (COE, 1984). This second forecast was based on significantly more information than

the first forecast. The most important new information included: two complete years of suspended-sediment measurements on the North Fork Toutle, Toutle, and Cowlitz rivers; geomorphic analysis of the avalanche (OSU, 1984); and additional cross-section surveys on the avalanche and the Cowlitz River.

To predict erosion, the avalanche was divided into subreaches based on distinct geomorphic characteristics. Erosion was then forecast for each sub-reach based on the observed rate of erosion and a geomorphic evaluation of the sediment available. The initial sub-reach rates were balanced against estimates of the erosion caused by various processes. A similiar method was used on the Toutle River. Cowlitz River deposition was again predicted based on sediment transport modeling using the HEC-6 computer program, as was Columbia River deposition. The principle conclusions of the SS/84 sediment forecast were:

1. The forecast erosion would be 28 mcy in WY 1985, declining to 16 mcy per year by the end of the century and to 7 mcy per year by 2034. The total erosion from 1980 through 2034 was estimated to be 750 mcy.

2. The Toutle River would be a sediment source during the first 10 years.

3. Cowlitz River deposition would accumulate to a maximum of 78 mcy and then erode slowly.

4. Columbia River deposition would occur primarily near the mouth of the Cowlitz and would total 145 mcy.

Following is a comparison of the studies conclusions:

Year of Study	Avalanche Initial Year (mcy)	Erosion Total 1980-2035 (mcy)	Cowlitz River Deposition (mcy)	Columbia River Dredging (mcy)
1983	50	1000	50	240
1984	28	750	78	145
1985	23	630	120	0

Critical Elements

The critical elements affecting this sediment forecast are identified below. Each critical element is explained in detail later in this appendix.

Erosion

The observed erosion and geomorphic development on the debris avalanche and the volcanic/mudflow activity of Mount St. Helens are critical elements in determining the initial sediment yields. The total volume of erosion is controlled by the availability of material and the presence of water, either from hydrologic or volcanic events in sufficient volumes to transport the sediment materials. Future hydrologic and volcanic events are critical elements in the long-term forecast. Because of the short period of record and complexity of the analysis, the forecast was reviewed by a group of expert consultatnts which recommended a final adjustment for consideration.

Deposition

The critical elements in determining deposition are the volume and gradation of the sediment inflow, and the transport capabilities of the respective rivers. The impacts of deposition varies depending on its location within the river system.

Study Limitations

The long-term forecasting of sediment erosion, transport, and deposition in a highly disturbed watershed like the Toutle-Cowlitz-Columbia, is complicated by the absence of proven analytical techniques, a short period of record since the May 1980 eruption, and the lack of major storm events which would demonstrate effects of low frequency storm-on-sediment erosion. However, some review was made of significantly disturbed basins in California and a team of Corps experts visited Japan to evaluate volcanic erosion and control works in that country. The data base and analysis methods used to produce this forecast were developed over the past 3 to 5 years. The sediment forecast presented in this report is based on the current level of understanding of the sedimentation processes occurring in the watershed. The COE and USGS monitoring programs have produced a large amount of high quality data which was used to develop a number of theories on the sedimentation processes. However, because of the short period of record, it is difficult to determine the significance of some of the apparent trends. In extreme cases, there may be two or three conflicting theories among experts about the existence, meaning, or significance of some trends.

This sediment forecast is made for average annual hydrologic and volcanic conditions. The hydrologic average is based on over 50 years of streamflows. Individual years vary greatly above and below the average annual discharge. The volcanic average is based on the 4 year period from 1981 to 1985. There are no ways to determine future hydrologic or volcanic events. Therefore, the actual volumes of sediment erosion and deposition in any single year are likely to be significantly above or below those forecast. However, the long-term averages are expected to be similar to the forecast trend.

DEBRIS AVALANCHE EROSION

Introduction, Sediment Forecast

The purpose of the sediment forecast is to evaluate the expected intensity and duration of sediment yields from the debris avalanche. A more thorough discussion of processes of erosion and sediment yields from the debris avalanche can be found in Mt. St. Helens, Cowlitz and Toutle Rivers,

Sedimentation Study/1984. This appendix contains adjusted numbers and projections from studies completed since 1984.

With the estimate of expected sediment yields, it is possible to assess downstream impacts in the Cowlitz and Columbia Rivers for purposes of project formulation. The two major activities of the sediment forecast were to 1) Estimate an initial average annual sediment yield based on post eruption sediment yields, adjusted by a sediment yield simulation technique for a much greater range of hydrology and 2) to estimate the total volume and the rate of decay of erosion from the channel reaches of the debris avalanche.

Initial Average Annual Sediment Yields

The initial average annual sediment yield was the result of calculations of post eruption sediment yields from the debris avalanche adjusted by a suspended sediment simulation technique to incorporate a wider spectrum of flows. An estimate of unmeasured sediment discharge and sediment yields from mudflows was added for the initial average annual sediment yields.

Post Eruption Sediment Yields

The post eruption sediment yields were derived from computations of erosion of sequential cross sections in the debris avalanche and sediment measurements at the Kid Valley USGS stream gage. The results of sediment yields from the two methods can be seen in Table A-1.

TABLE A-1
SEDIMENT YIELDS FROM THE DEBRIS AVALANCHE
COMPARISON OF AVERAGE END AREA AND GAGE DATA
WATER YEARS 1981-1985
IN MILLIONS OF CUBIC YARDS[1]

PERIOD	AVE. END AREA	KID VALLEY GAGE
1981-1982	40	44
1983-1984	39	36
1985	4	4
1981-1985	83	84

1=total tonnage converted to volume by multiplying by 0.67 cubic yards/ton.

As can be seen in Table A-1 approximately 83-84 mcy of sediment was calculated to have eroded from the debris avalanche from water years 1981-1985. The average for the five year period is approximately 17 mcy/year. The post eruptive period has shown a spectrum of flows. A synopsis of post eruption flows based on a cumulative frequency analysis is reported in Table A-2.

TABLE A-2
RECURRENCE INTERVAL OF
MAXIMUM 1-, 7-, AND 183-DAY
TOUTLE RIVER DISCHARGES FOR
WY 1981 to 1985

	Average Exceedence Interval in Years		
Water Year	1 Day	7 Day	183-Day
1981	3	PR1/	PR1/
1982	20	10	8
1983	4	4	5
1984	<2	2	2
1985	<2	<2	PR1/

1/ PR = Partial Record. No analysis possible at this date.

Based on the above cumulative volume frequency analysis, the post eruption period has had two above average years (water years 1982, 1983), one below average (water year 1985), and one average year of stream flow (water year 1984). The 1981 water year is considered to be slightly below average based on a partial record of stream flow and precipitation records.

Sediment Yield Simulation

Because of the short (5-year) post-eruption streamflow and suspended sediment record, a simulation approach was utilized to extend the data set for purposes of determining average sediment yields from the debris avalanche.

Suspended sediment yields were estimated by simulation and estimates for the unmeasured sediment and mudflow discharges were then added for estimates of total sediment load from the debris avalanche for average hydrologic conditions.

Suspended Sediment Simulation

Fifty years of daily suspended sediment records were simulated for the North Fork Toutle River to determine the average sediment yields under a variety of sediment discharge/water discharge relationships (sediment rating curve) and variations of hydrologic conditions. The sediment rating curves are a log/log regression of sediment discharge and water discharge for the 1980-1984 water years (Figure A-1).

Average annual sediment yields were calculated from the regression equation of the sediment rating curves and daily flow from the North Fork Toutle River flow record. Figure A-2 shows the results of the 50 year simulation for the four sediment rating curves. As can be seen in Figure A-2 the 1982, 1983, and 1984 water years sediment rating curves predict similar quantities of sediment yields over the 50 year simulation.

Statistics that estimate central tendencies (such as mean, standard deviation, skewness, and kurtosis) were calculated for the flow record and each sediment rating curve. The average sediment yield for the 4 years of the sediment rating curves were 25, 14, 17, and 13 mcy/year for the 1981, 1982, 1983, and 1984 sediment rating curves, respectively. Statistical calculations of skewness and kurtosis showed a normal distribution, hence an arithmetic mean average of sediment yields is an appropriate conservative estimate of yield.

The 1982 water year suspended sediment rating curve was selected as the best estimate of the expected conditions because it encompassed the widest range of flows. Therefore, the projection for average annual suspended sediment yields under present conditions is 14 mcy.

Unmeasured Sediment Discharge: The unmeasured sediment discharge is the sediment in the stream column that cannot be measured with a suspended sediment sampler, either because the particle is too large to be sampled or it is in transport in the stream column below the orifice of the sampler. The unmeasured sediment load can vary from near zero to well over 200 percent of the measured suspended sediment (Colby, 1957). The unmeasured load on the North Fork Toutle River has been estimated to be 15 percent (or 2 mcy in the first year) of the measured suspended sediment. This estimate is based on

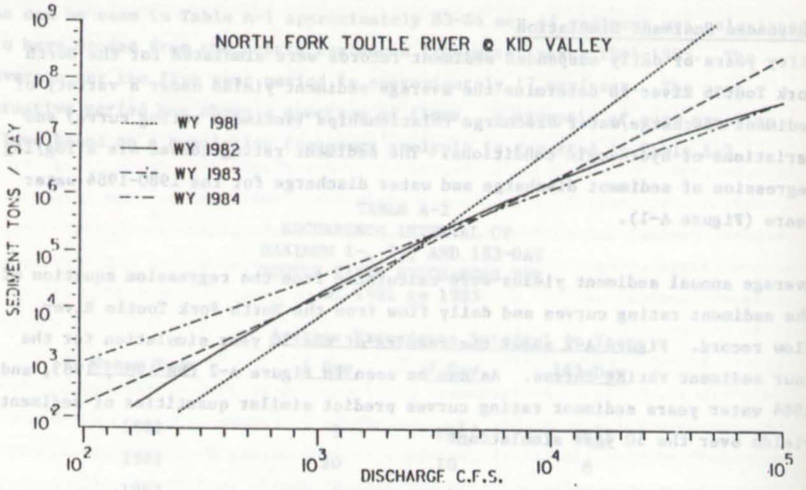

FIGURE A-1: SEDIMENT RATING CURVES

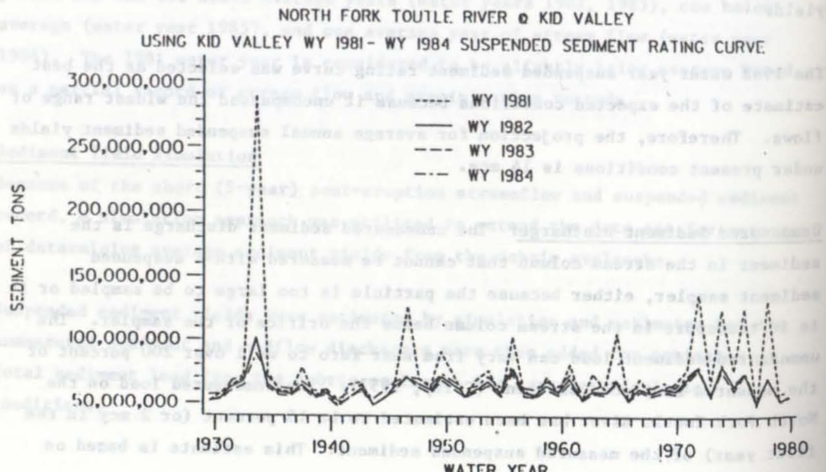

FIGURE A-2: SUSPENDED SEDIMENT SIMULATION

calculations from the Modified Einstein total load sediment transport formula and preliminary measurements from the Helley Smith bedload sampler.

In the absence of a long historical mudflow record or the identiication of a definite trend in eruptive activity, it was assumed the same conditions and processes that have existed over the past 5 years to continue in the immediate future (Figure A-3). Therefore, the best way to estimate the average annual sediment contribution from mudflows is to look at those past 5 years of record. Three significant mudflow events have occurred since 1980 (March 1982, February 1983, and May 1984: Figure A-4). If the total volume of all three events since 1980, 20 mcy was divided by the four full winters with a permanent snow pack, 1981-84 of record the result is a potential 5 mcy of mudflow introduced into the system annually.

In relating maximum total volumes of mudflow to sediment volume, consideration must be given to mudflow sediment concentrations and densities. Mudflow sediment concentrations vary with each event. Assuming an average concentration of 80 percent solids by weight for a mudflow and that avalanche and pyroclastic deposits with a typical density of 110 lbs/ft^3 were the major sources of sediment for a mudflow. Then a mudflow with a volume of 1 mcy and a sediment concentration of 80 percent by weight (60 percent solids by volume), erodes .9 mcy of material. Therefore, an average annual mudflow volume of 5 mcy would erode 4.5 mcy of sediment (5 mcy times .9). Because of the uncertainties associated with mudflow estimates, the volume was kept at 5 mcy.

Some of the sediment carried by a mudflow is deposited downstream before it passes the N-1 Sediment Retention Structure. The quantity of sediment transported past N-1 by a mudflow varies greatly with each event and is dependent on a number of factors, including mudflow volumes, concentrations, routing, channel morphology, and stream flows at the time of an event. The biggest pulse of sediment from a mudflow is transported during the first 2 days of an event, but elevated levels of sediment transport continue for weeks or even months afterwards as the river erodes the soft mudflow deposits. Twenty-five percent of the sediment transported by the March 1982 mudflow passed the Kid Valley gage in the first 2 days. An estimated average of 80 perent of the sediment passes N-1 within a few weeks of the event. The

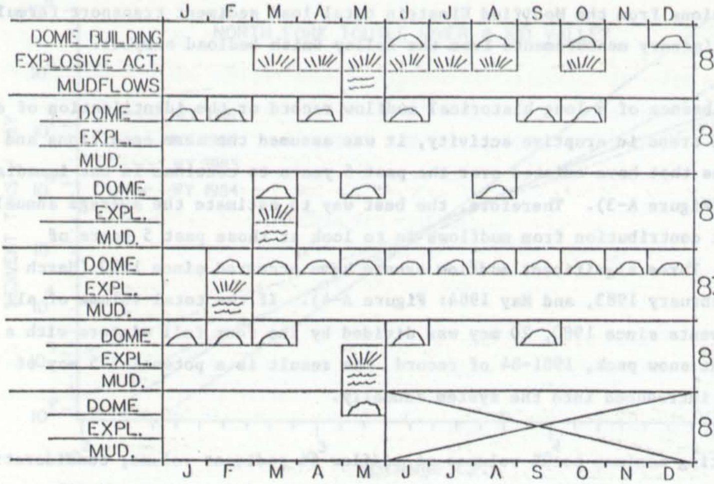

FIGURE A-3: MOUNT ST. HELENS ERUPTIVE ACTIVITY 1980-1985

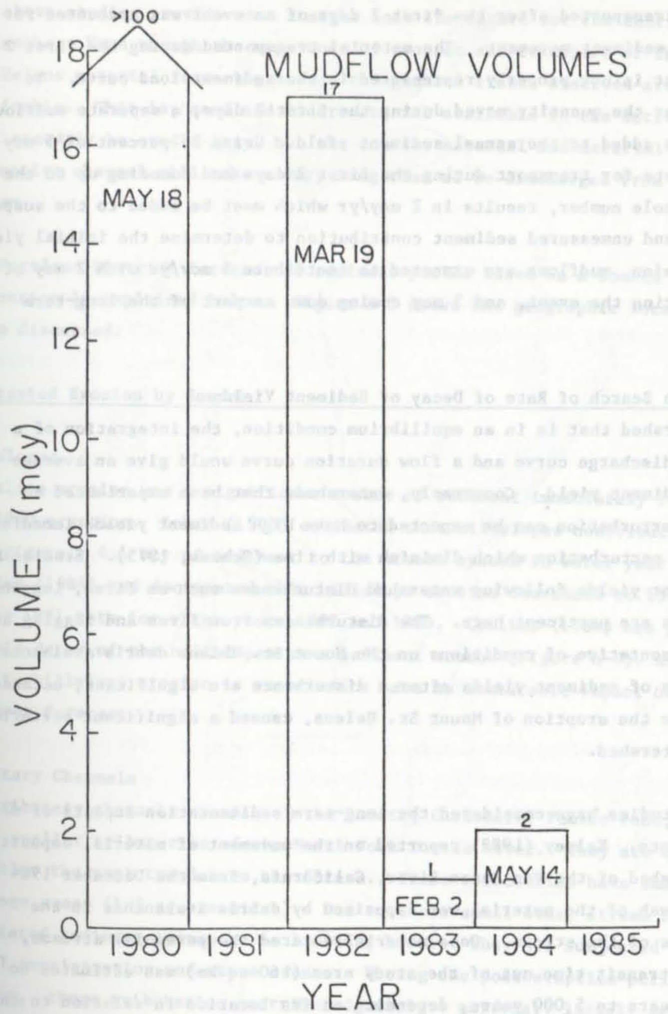

FIGURE A-4: MUDFLOW VOLUMES 1980-1985

material transported after the first 2 days of an event was accounted for in suspended sediment movement. The material transported during the first 2 days of an event is not properly represented in the sediment load curve. To account for the quantity moved during the first 2 days, a separate mudflow factor was added to the annual sediment yield. Using 25 percent of 5 mcy as the estimate for transport during the first 2 days and rounding up to the nearest whole number, results in 2 mcy/yr which must be added to the suspended sediment and unmeasured sediment contribution to determine the initial yield. In conclusion, mudflows are expected to contribute 5 mcy/yr with 2 mcy of that coming during the event, and 3 mcy coming down as part of the long-term average.

Literature Search of Rate of Decay of Sediment Yields

In a watershed that is in an equilibrium condition, the integration of a sediment discharge curve and a flow duration curve would give an average annual sediment yield. Conversely, watersheds that have experienced an intense perturbation can be expected to have high sediment yields immediately after the perturbation which diminish with time (Schumm, 1975). Studies made of sediment yields following watershed disturbances such as fires, logging, and floods are pertinent here. The disturbances from fires and logging are not representative of conditions on the Mount St. Helens debris avalanche but the trends of sediment yields after a disturbance are significant, because they, like the eruption of Mount St. Helens, caused a significant perturbation to the watershed.

Several studies have considered the long-term sedimentation impacts of major flood events. Kelsey (1982) reported on the movement of material deposited in the streambed of the Van Duzen River, California, from the December 1964 flood. Much of the material was deposited by debris avalanches in the headwaters of the stream. Once material entered the perennial streams, sediment transit time out of the study area (160 sq km) was estimated to range from 10 years to 5,000 years, depending on its location in relation to the active channel. Brown and Ritter (1971) concluded that the December 1964 storms doubled the sediment yield rates on the Eel River through processes similar to those observed by Kelsey.

The above studies provide some insight into the future for the debris avalanche. Even though the magnitude of erosion and transport of the Mount St. Helens material is much greater, the general trends observed are applicable. That is, sand and finer material available in the active channel will steadily be eroded away, but the coarser material and material outside the active channel will take a very long time to be discharged from the system.

The Portland District forecast of sediment yields based on a source by source evaluation is explained below. Figure A-5 shows the geographic location of areas discussed.

Forecasted Erosion by Source

Hillslopes

Hillslope erosion was a significant source of sediment immediately following the 1980 eruption. Lehre (1983) estimated that hillslopes contributed approximately 6.1 mcy of sediment to the stream system in water year 1981. Collins (1984) had documented that hillslope erosion decreased to 15% and 7% of the 1981 rate for water years 1982 and 1983. Collins (1984) has projected a rapid decay of the hillslopes as a sediment source (Figure A-6). As a result, hillslope erosion is expected to have no measurable impact on the sediment forecast.

Tributary Channels

The tributary channels consist of the Loowit, Carbonate, Pumice Pond, and other smaller tributaries of the North Fork Toutle River. They are expected to follow the past trend into the future. These tributaries have small drainage areas (1-3 square miles). Due to their small size, stream flow and associated sediment transport is limited, however they are subjected to high annual precipitation and storm events. During the post eruption period, however, these tributaries contributed nearly 4 mcy/year, largely as a result of mudflows from Mount St. Helens and as a response to changes in base level of the N. Fork Toutle River. The upper tributaries, such as the Pumice Pond, Loowit, and Carbonate Creek are expected to show a constant sediment yield

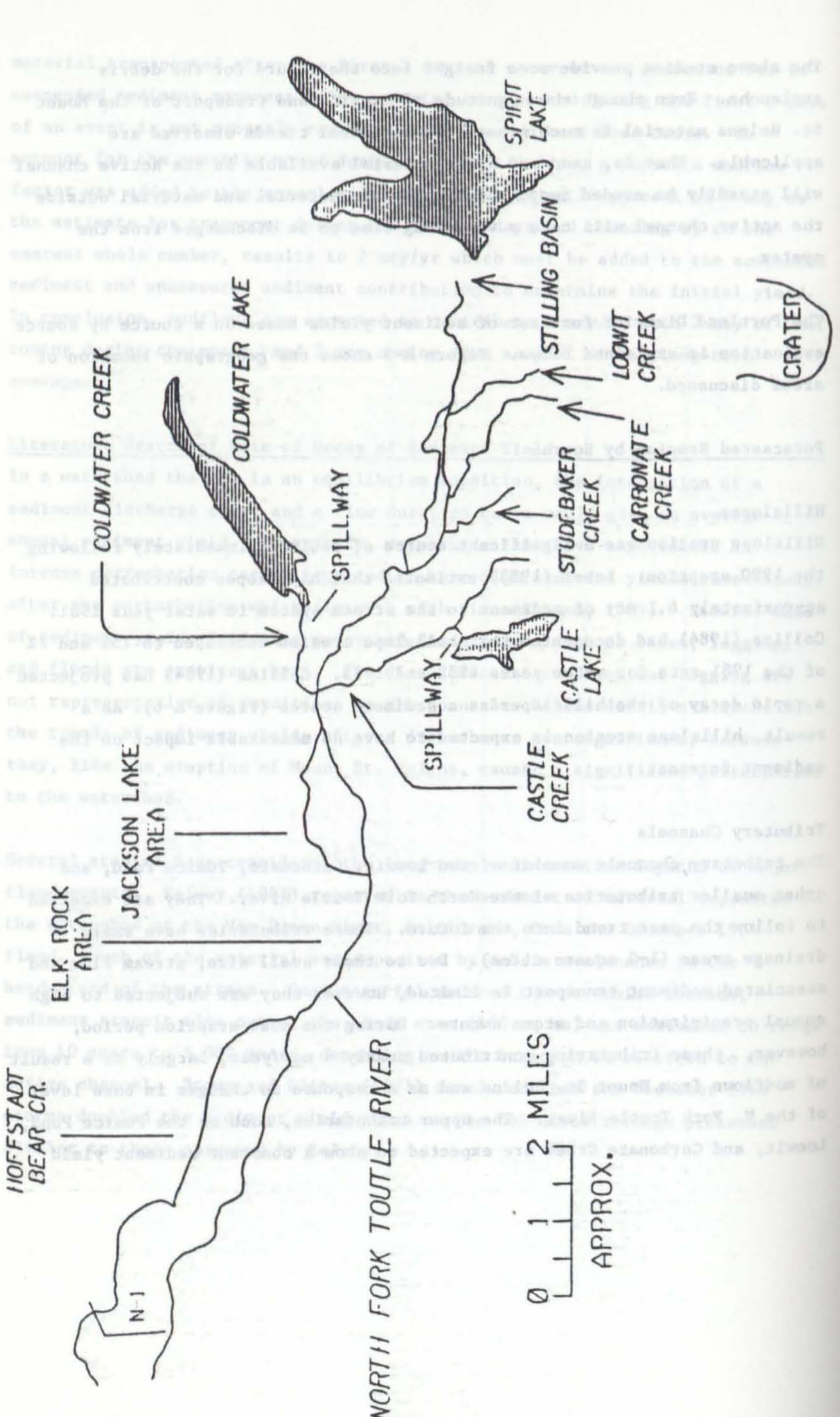

FIGURE A-5: AVALANCHE AREA LOCATION MAP, NORTH FORK TOUTLE RIVER, WASHINGTON

from mudflows during the next 50 years. The lack of significant decay in sediment yields is because the channels are eroding through a generally fine grained, low bulk density deposit that is periodically disturbed by mudflows. Factors, such as accumulations of coarser aluvium, that may promote a sediment decline, are not expected to occur. As a result, sediment yields from these tributary channels are equal to the present natural rate of sediment production (4-5 mcy/year)through the next 50 years.

The controlled breaching of Coldwater Lake caused nearly 2 mcy of erosion in the late 1981/early 1982 water year. The Coldwater Creek outlet is expected to be stable in the future. Thus, there is no significant sediment yield expected from this channel.

Castle Creek Channel

The Castle Creek channel evolved rapidly after the 1980 eruption through initial incision of the channel. Bank erosion was the most important source of sediment there since WY 1982. Post eruption sediment yields average 2 mcy/year. Sediment yields are expected to decline from 2mcy/year at present to negligible within 8 years for a total of 8 mcy.

North Fork Toutle River

The North Fork Toutle River will be a large source of sediment. The channel can be broken into three distinct morphological reaches: 1) from the Spirit Lake divide to the Coldwater outlet, 2) Coldwater Lake outlet to the Elk Rock valley constriction, and 3) reworked fluvial sediment, from the Coldwater Lake outlet to the N-1 debris retention structure. The distinction is appropriate for purposes of evaluating expected hydrologic and associated sediment transport associated with the Spirit Lake diversion tunnel.

Spirit Lake to Coldwater Outlet: The Spirit Lake to Coldwater reach has developed largely as a response to the Spirit Lake pumping operation. Prior to the inception of pumping, this reach was a depositional area. The pumping operation greatly increased the discharge into the reach. Nearly 22 mcy of sediment has eroded from this reach during the post eruption period but over 16 mcy can be directly attributed to

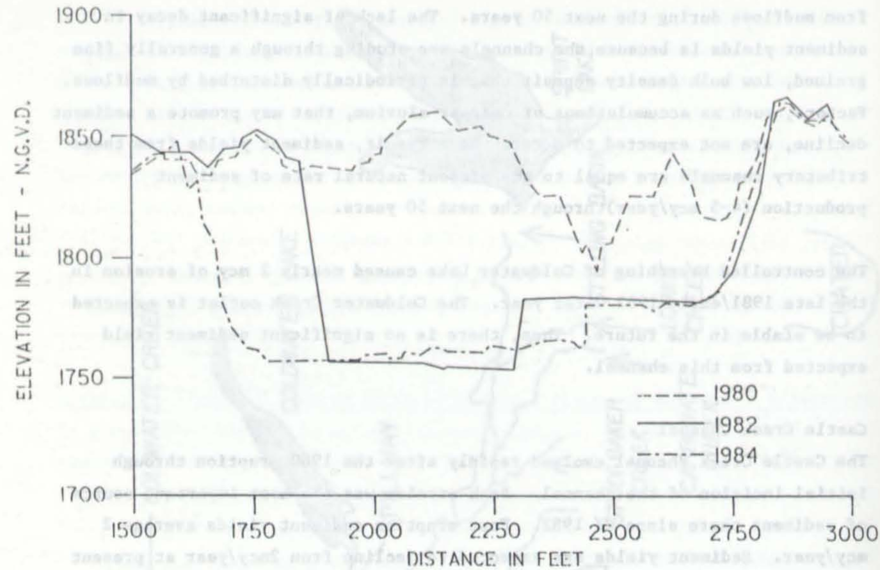

FIGURE A-6: CROSS SECTION 19-168

erosion from the Spirit Lake pumping operation. Much of the channel is armored to flow conditions that will greatly exceed post project conditions. As a result, sediment yields from this reach are expected to decrease dramatically from the pumping condition yields of 4-12 mcy/year to less than 1 mcy/year without pumping.

Coldwater Outlet to Elk Rock: The Coldwater to Elk Rock reach has evolved rapidly during the post eruption period. Initially, the Elk Rock area formed a large blockage in a narrow portion of the N. Fork Toutle River valley. This reach cut down rapidly through the blockage forming channel banks greater than 100 feet high. Incision has decreased dramatically since the end of the 1982 water year. Since that time, bank widening has been the predominant source of sediment. Figure A-6 shows the development of a representative cross section from the Elk Rock blockage area during the past eruptive period. Erosion from this reach has averaged nearly 8 mcy/year.

Post Spirit Lake diversion tunnel discharge should continue to destabilize this reach. High discharges of sediment free water should cause rapid bank and bed erosion. It is projected that bank erosion will be the predominant source of sediment in the future. Bank erosion should continue until all of the available debris avalanche deposit is removed above the present bed of the North Fork Toutle River, leaving behind a residue of coarse gravels and cobbles. Sediment yields are expected to decline from 8 mcy during the 1986 water year to less than 1 mcy/year by water year 2000 for a total of 60 mcy.

Once the stream has worked its way across the valley (in 15 to 20 years), the erosion rates will be similar to those observed in other reworked fluvial reaches of the avalanche.

Reworked Fluvial Sediments: This reach consists of approximately 60 mcy of reworked fluvial sediments from the N-1 debris retention structure to the Coldwater outlet. As the Elk Rock blockage is eroded and sediment is preferentially transported, the volume of the reworked fluvium is expected to increase to approximately 100 mcy. It is expected that as sediment yields are reduced from the upstream reaches, that this reach will change from a sediment

sink to a sediment source. The fluvial deposits will not be eroded and transported as rapidly as the avalanche deposits since they are somewhat coarser. A grain size stability analysis indicates, however, that the partical sizes found in the bed of the river are substantially less than those required for channel armoring at high discharges. The channel may continue to switch back and forth between the North Fork channel on the south side of the valley, Bear Creek channel on the north, and between the two channels through the center of the valley. Projected sediment yields from the fluvial deposits are expected to be 1 mcy/year through the next 50 years leaving a coarse residuum of gravel, cobbles, and boulders.

Forecast Conclusions, Base Sediment Budget

Table A-3 summarizes the forecasted sediment yields from the reaches of the debris avalanche discussed above. The values shown in Table A-3 are intended to show the relative significance of the various reaches and the yield decay which is expected to occur over time. Variability in hydrologic and volcanic events is expected to cause variations from the sediment yields shown on Table A-3 on both a year-by-year and a reach-by-reach basis. Figure A-7 shows the projected sediment yields from the debris avalanche. In general, the forecasted sediment budget, as presented, is a mudflow dominated budget. The Elk Rock reach is the only area where significant quantities of sediment yield are expected that are not directly or indirectly related to mudflows.

TABLE A-3

FORECAST EROSION FROM THE DEBRIS AVALANCHE

(mcy/year)

	1986	1995	2010	2035	TOTAL
Hillslope	0	0	0	0	0
Mt. St. Helens	2	2	2	2	100
Pumice Pond, Loowit	5	5	4	4	225
Carbonate, Coldwater					
Castle Creek	2	0	0	0	8
Spirit Lake-	<1	0	0	0	0
Coldwater Outlet					
Coldwater Outlet-	8	2	0	0	60
Elk Rock					
Reworked Fluvium	1	1	1	1	50
Total of Above	18	10	7	7	443 1/

1/ Rounded to 440 mcy

Recommended Forecast, 550 MCY Sediment Budget

In May, 1985 there was a second meeting of the Sediment Advisory Group at which the Portland District presented the 440 mcy forecast. That review resulted in a recommendation that an additional 25%- 50% should be added to the forecast.(See Exhibit A-2 for the consultants' comments on that meeting.) Following is the rationale for the addition:

"1. We have carefully reviewed the quantities and over-all results of the District's analysis and consider that a degree of conservatism is warranted in the estimate of avalanche yield over 50 years for the following reasons:

a. Even though the monitoring has been at a high quality and quantity level, hydrologic events during the 5 years since the eruption have not yielded a good sampling of what can occur in the future.

b. Modeling studies since our last meeting indicate that much more incision into the avalanche can occur than was previously considered.

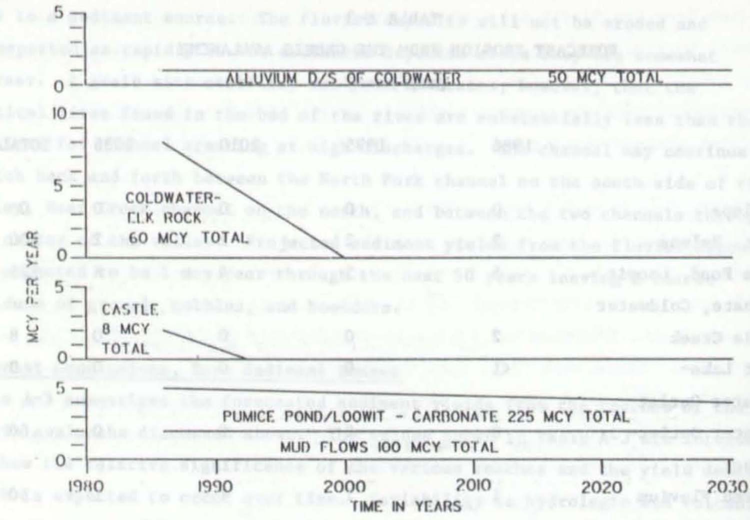

FIGURE A-7: PROJECTED 50 YEAR EROSION (440 BUDGET)

c. The possible sequences of channel degradation, widening, and migration within the avalanche area are many and are difficult to predict. Such changes can greatly influence the rate by which erosion decreases with time.

2. As a consequence of this concern, the consultants suggest that the 50-year sediment yield of 440 mcy may be increased by 25 to 50 percent.

3. The primary change is an increase in the erosion downstream of Coldwater Creek because of the increased ability to incise as demonstrated by the model, and availability of material. The suggested yield increase depletes a total of only 15 percent of the avalanche material in 50 years, including 25 percent of the material in the Elk Rock-Coldwater reach."

As a result, the Portland District, in a joint review meeting with the North Pacific Division and the Office of the Chief Engineers, agreed that the expert opinions were valid and that the base estimates should be adjustment. For the reasons cited by NPD and WES representatives concerning potential avalanche erosion due to low-frequency hydrologic events and the reasons given in the consultants report, the Corps of Engineers increased the base budget from 440 mcy to 550 mcy. The current sediment budget has an initial sediment yield of 23 mcy/year and a total yield of 550 mcy over the period of water year 1986-2035.

Erosion and Deposition Downstream from the Debris Avalanche

Changes in volumes of sediment transport and deposition continue below the debris avalanche. There are 37 RMs between the terminus of the debris avalanche and the confluence of the Toutle River with the Cowlitz River. Within this reach nearly 10 mcy of material have eroded and millions more could potentially erode. Since WY 1981 the North Fork and main stem of the Toutle River have responded in much the same way as the debris avalanche, with general channel aggradation and bank erosion. Repeated cross-sections surveyed by the USGS and COE were used to determine sources and quantities of erosion on the lower 37 miles of the North Fork Toutle and Toutle rivers. Table A-4 shows the results of the cross section data.

TABLE A-4

NORTH FORK AND TOUTLE RIVER SEDIMENT YIELDS

WATER YEAR 1981-84

AVE. END AREA METHOD

REACH	YIELDS (MCY)
N1 - KID VALLEY	-4.3 (DEPOSITION)
NF1	2.9
LT3	3.5
LT1	3.2
NET TOTAL EROSION	5.3
GROSS TOTAL EROSION	9.6

As can be seen in Table A-4, the North Fork and the Main Stem Toutle Rivers downstream of the Kid Valley area are a significant source of sediment during the post eruptive period.

Erosion Forecast

Most of the measured erosion downstream of the debris avalanche occured from 1981-1983. The process of bank erosion is self limiting. As a result it is expected that erosion rates will diminish rapidly with time. Forecasted erosion is 2,1,1, and 0 mcy per year for water years 1986, 1987, 1988 and 1989 respectively.

SEDIMENT DEPOSITION FORECAST

Introduction

The following is a discussion of the sediment deposition forecast for the Cowlitz and Columbia rivers over the next 50 years. The methods used to develop the forecasts, the critical elements involved in the forecast, and the impacts of deposition on Cowlitz River flood heights and the Columbia River are discussed.

Cowlitz River

Cowlitz River deposition is dependent on the volume and gradation of sediment delivered by the Toutle River and on the Cowlitz River's own sediment transport capability. The predicted sediment erosion was discussed in detail earlier. However a final adjustment in sediment delivery volumes is described in this section. An evaluation of the Cowlitz River's transport capability and depositional characteristics, based on observed data, is also described in this section.

Toutle River Sediment Delivery

The sediment yield from the Toutle basin, espressed in terms of expected volume of erosion, was presented previously. However, since volume is related to the inplace volume of the material, there is a significant increase between a given volume of erosion and the resulting volume of deposition. The increase in volume is caused by a reduction in unit weight between the original avalanche deposit and the resulting alluvial deposit. In this case, the average unit weight of the debris avalanche was estimated to be 110 lb/ft^3, while the Cowlitz River deposits have an estimated average unit weight of 95 lb/ft^3. When this reduction in unit weight is accounted for, it results in a 16% increase in volume. The impact this has on the Toutle River sediment delivery is shown on Figure A-8.

The particle size of future Toutle River sediment discharges is assumed to be similiar to those observed since the eruption for this forecast. Table A-5 lists the average size class percentages for the total sediment discharge during WY 1982 through WY 1984. This estimate was based on Toutle River suspended-sediment measurements taken at Tower Road and on bed material gradations taken downstream of Tower Road in both the Cowlitz and Toutle rivers. The grain size distribution listed in Table A-5 was assumed to be the distribution throughout the forecast period.

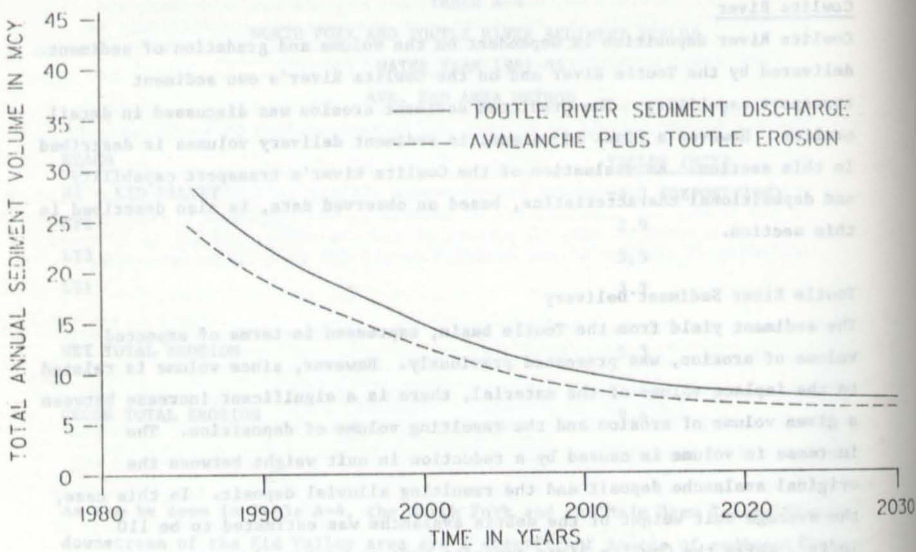

FIGURE A-8: TOUTLE RIVER EROSION/YIELD FORECAST (440 BUDGET)

TABLE A-5

TOUTLE RIVER SEDIMENT DISCHARGE, GRAIN SIZE DISTRIBUTION

Size Class	Percentage of Total
Silt/Clay	42
Very Fine Sand	17
Fine Sand	20
Medium Sand	11
Coarse Sand	5
Very Coarse Sand and Gravel	5

Cowlitz River Sediment Transport

For purposes of this study, it was necessary to estimate the average annual sediment transport capacity of the Cowlitz River. This capacity is influenced by individual storm events in all seasons, but is most dependent on the conditions during the November through March flood season. Streamflows during that time vary greatly, but follow a similiar pattern from year to year. It was, therefore, assumed that the average annual transport capacity remains constant for any combination of flow conditions which aggregate to average conditions.

The COE and USGS monitoring programs on the Cowlitz and Toutle rivers have provided an excellent data base from which to analyze transport capacity. This data base includes Toutle and Cowlitz river streamflow and suspended-sediment measurements, Toutle and Cowlitz rivers dredging volumes, Cowlitz River deposition volumes, grain size information, and stream profiles. Because of the quality and quantity of available data and the limitations of past sediment transport modeling (SS/84) it was decided to use only the observed data to estimate the average annual transport capacity.

The annual transport rate of the Cowlitz River was determined from mass balance calculations for each of the 3 years from WY 1982 through WY 1984. In

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those calculations the volume of deposition in the Cowlitz River and at LT-1 was subtracted from the total sediment inflow to arrive at the amount of sediment transport. The deposition that occurred in the sump at the mouth of the Cowlitz river was excluded in these calculations since that material was deposited because of the sump. Because grain size is an important factor in sediment transport, the above calculations were done for selected grain sizes.

The results of the mass balance calculations are shown on Table A-6. The annual rates show some variation, but the individual grain sizes exhibit consistent trends. Silts and clays make up an insignificant portion of the Cowlitz River's bed, indicating that the Cowlitz has transported essentially all these materials received from the Toutle River. Silts and clays can therefore be considered wash load and are not expected to deposit in the future. Sand sizes from very fine up to coarse are generally transported as suspended-sediment by both the Toutle and Cowlitz rivers. However, in the Cowlitz River these sizes are selectively deposited as the transport rate varies greatly between sizes. Most of the very fine sand reaching the Cowlitz is transported through, while all of the coarse sands are deposited. Very coarse sand and gravels are transported as bedload by the Toutle and move only a few miles in the Cowlitz River before they are all deposited.

TABLE A-6
COWLITZ RIVER SEDIMENT INFLOW AND OUTFLOW
FOR WATER YEARS 1982 THROUGH 1984 IN MCY

Size Class	WY 1982 Inflow	WY 1982 Outflow	WY 1983 Inflow	WY 1983 Outflow	WY 1984 Inflow	WY 1984 Outflow
Silt/Clay	16.1	16.0	13.7	13.6	7.7	7.6
Very Fine Sand	6.6	5.9	5.7	5.2	3.0	2.8
Fine Sand	6.2	3.2	7.2	5.0	4.6	3.2
Medium Sand	3.1	0	3.8	1.1	3.2	1.0
Coarse Sand	1.8	0	1.5	0	1.3	0
Very Coarse Sand and Gravel	1.6	0	1.0	0	1.7	0

The sediment inflows and Cowlitz River discharges during WY 1984 were the closest of the 3 years to the expected initial average annual conditions of the 440 mcy base estimate. Water year 1984 therefore provided the basis for estimating the Cowltiz River's average annual transport potential (Table A-7). The observed WY 1984 rates were used for all sizes except very fine sand. Based on the higher transport rates of very fine sand observed in WY's 1982 and 1983, and of fine sand in WY 1984, the potential for very fine sand was raised from 2.8 mcy/yr observed in WY 1984 to 3.5 mcy/yr.

TABLE A-7

AVERAGE ANNUAL COWLITZ RIVER SEDIMENT TRANSPORT IN MCY

Size Class	Annual Transport mcy
Silt/Clay	10+
Very Fine Sand	3.5
Fine Sand	3.2
Medium Sand	1.0
Coarse Sand	0
Very Coarse Sand and Gravel	0

Cowlitz River Deposition

The two important elements of Cowlitz River deposition are the volume and the distribution. Each of these are discussed in the following paragraphs.

The volume of sediment forecast to deposit annually in the Cowlitz River over the next 50 years is shown in Figure A-9. That deposition was predicted by subtracting the average annual Cowlitz River transport potential from each of the predicted annual Toutle River sediment discharges. As Figure A-9 shows, deposition is expected to continue through the entire 50-year period. This is caused by the continuous deposition of all the coarse sand and larger

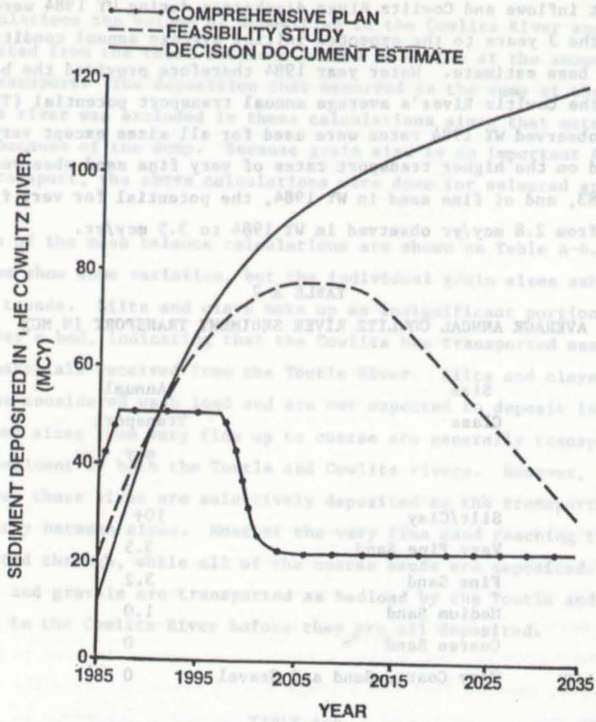

FIGURE A-9: COWLITZ RIVER DEPOSITION FORECAST

sediments in that reach of the Cowlitz River. The total deposition forecast to occur over the next 50 years is nearly 110 mcy, with 60% of the total being coarse sand and larger sediment.

The distribution of sediment within the Cowlitz River is needed to fully identify the potential damages. That distribution was extrapolated from current depositional patterns. Figures A-10 and A-11 show the deposition patterns for two reaches, RMs 0 to 10 and RMs 10 to 20, covering the Cowlitz River downstream of the Toutle confluence. Since October 1982, 80% of the net deposition in the Cowlitz River has occured upstream of RM 10, with only 20% downstream of that point. This depositional pattern is expected to continue in the future. The coarse sands and gravels are expected to continue to deposit upstream of RM 10 throughout the 50-year period. As bed levels in the channel rise, more and more sediment will be deposited in the floodplain. As the channel fills, the Cowlitz upstream of RM 10 will become very unstable and could begin to meander outside the current channel limits. Downstream in the Longview area the bed materials will be finer than near Castle Rock. Downstream of RM 10 deposition will be at a slower rate than in the upstream reach, but will also continue for 50 years. In this reach the Cowltiz channel should be maintained in its present alignment by the levee systems.

Cowlitz River Flood Profiles

Sediment deposition in the Cowlitz River causes an increase in potential flood heights and a corresponding decline in the level of protection for the communities of Longview, Kelso, Lexington and Castle Rock. Future flood heights are based on the amount of deposition expected in a reach and the observed relationship between flood heights and deposition within the reach. The flood height versus deposition relationships were determined by plotting the computed flood heights against the sediment volume in the appropriate reach, for each Cowlitz River survey since October 1981.

In addition to the annual deposition, each of the storms for which flood profiles were calculated added an increment to the volume deposited in the Cowlitz River. This increment is dependent on the design sand yield for each

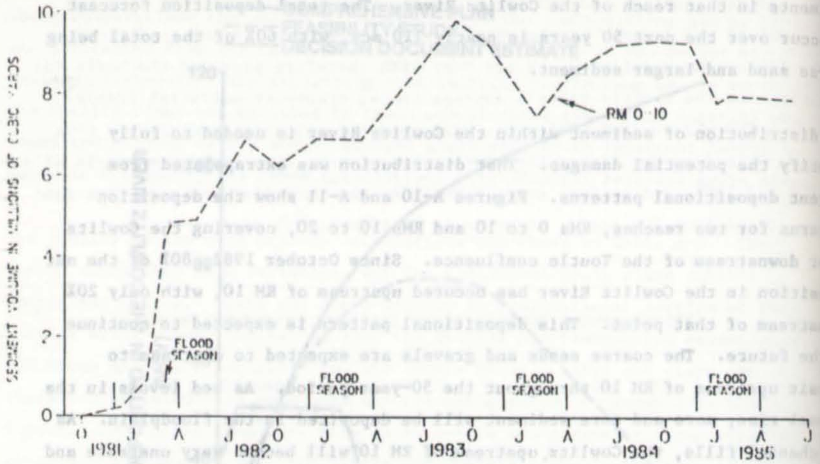

FIGURE A-10: OBSERVED COWLITZ RIVER DEPOSITION BETWEEN RM RM'S 0 AND 10 SINCE OCTOBER 1981

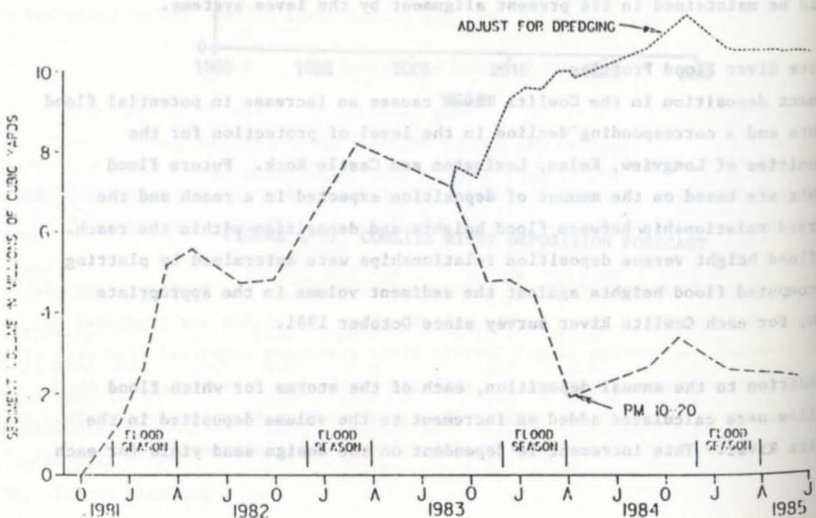

FIGURE A-11: OBSERVED COWLITZ RIVER DEPOSITION BETWEEN RM'S 10 AND 20 SINCE OCTOBER 1981

storm and is the amount expected to deposit prior to the flood peak. This concept is explained in the Comprehensive Plan and in the Cowlitz and Toutle Rivers Sedimentation Study 1980-1982. The sediment loads expected to occur during each of the storms are the same as those in SS/84; however, the expected deposition has been increased. This increase is the result of an analysis of observed deposition during WY's 1983 and 1984. The design sand yield and resulting deposition are shown in Table A-8.

TABLE A-8
DESIGN SAND YIELD AND DEPOSITION DURING "RISING SIDE" OF HYDROGRAPH FOR MAJOR FLOODS

Average Exceedence Interval	Design Sand Yield to Cowlitz (mcy)	Deposition in Cowlitz (mcy)
10	4.0	1.9
50	6.0	2.6
100	7.0	3.0
500	12.0	5.4

Figures A-12 and A-13 show the predicted flood elevation changes over time at RMs 5.5 and 17.6. These curves account for each of the factors discussed above. The curves are based on observed relationships between streamflow, sediment load, and deposition. Extrapolation beyond the observed range of data was necessary in many cases, due to the magnitude of the sediment problem.

Columbia River

This sediment deposition forecast for the Columbia River primarily addresses deposition which would affect the navigation channel and increase maintainance dredging costs. Deposition adjacent to the navigation channel is included to a limited degree, but side-channel, backwater, and estuarine deposition are not included.

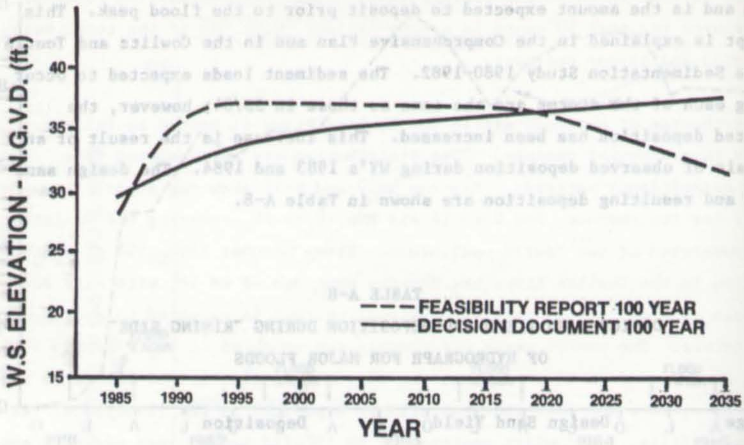

FIGURE A-12: 100-YEAR FLOOD ELEVATIONS AT COWLITZ RM 5.5

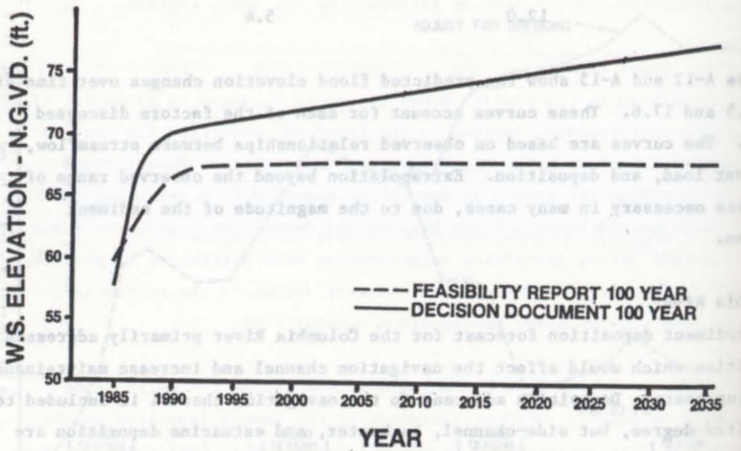

FIGURE A-13: 100-YEAR FLOOD ELEVATIONS AT COWLITZ RM 17.6

The sediment transport processes of the Columbia River are not well understood. The lack of historic data and the highly variable seasonal flow characteristics of the Columbia make the analysis of sediment transport all the more difficult. Two analyses of observed data were used to arrive at this deposition forecast. The first was a general aggradation/degradation evaluation between Rm 11 and RM 76 to identify potential depositional problems. The second was a more detailed analysis of Lower Dobelbower Bar, which was identified in the general evaluation as a potential problem.

Columbia River RM 11 to RM 76: An evaluation of aggradation/ degradation trends in the Columbia River between RM 11 and RM 76 was presented in the Columbia River Shoaling Study (COE, 1985). This evaluation used annual hydrographic surveys and dredging records to determine the naturally occurring changes in sediment volume along the main river channel since the 1980 eruption. The significant findings of this evaluation are:

1. All bars except Walker Island (Figure A-14) showed significant aggradation at some point following the eruption. This was most immediate and dramatic near the Cowltiz confluence. The aggradation was less pronounced and appears to have lagged up to a year in the downstream reaches.

2. Most bars have subsequently shown a degradation trend toward recovery from the initial eruption caused deposition.

3. Only three bars showed an increase of 1 mcy or more in sediment volume over the 1982 and 1983 water years, while five bars showed reductions of that magnitude (table A-9).

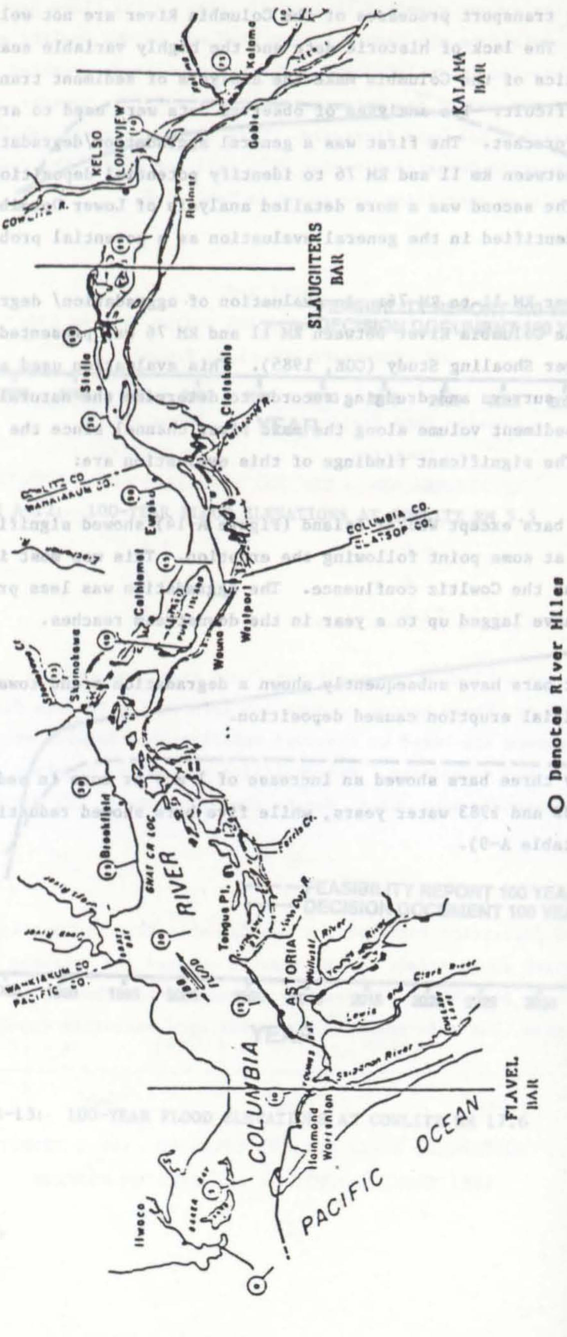

FIGURE A-14: AREA MAP OF COLUMBIA RIVER BARS

TABLE A-9

POST ERUPTION TRENDS IN

AGGRADATION/DEGRADATION

OF COLUMBIA RIVER REACHES

Bar Name	Significant Aggradation	Near Equilibrium	Significant Degradation
Kalama		X	
Upper Dobelbower		X	
Lower Dobelbower	X		
Slaughters		X	
Walker Island		X	
Stella Fisher		X	
Gull Island	X		
Eureka	X		
Westport		X	
Wauna-Driscoll		X	
Puget Island		X	
Skamokawa			X
Brookfield-Welch			X
Pillar Rock			X
Miller Sands		X	
Tongue Pt. Crossing			X
Flavel			X

Significant aggradation or degradation is arbitrarily defined as that which exceeds 1 mcy over the 1983 and 1984 hydrographic surveys.

The above findings indicate that during a two year period, when over 14 mcy of sand were discharged into the Columbia River, there were only three bars which experienced over 1 mcy of aggradation. Of those three, only Lower Dobelbower is a factor in this forecast, as the other two have required only minor amounts of dredging.

Lower Dobelbower Bar: Lower Dobelbower Bar is located between RM's 67 and 70 and includes the Cowlitz River confluence. In reviewing the deposition which has occurred in this reach there were two factors which seemed to be of over-riding importance; the location of deposition and the gradation of the sediments.

The annual deposition identified in the general evaluation was predominately located upstream of the mouth of the Cowlitz River. Because this reach of the Columbia River does not experience flow reversals, such as occur in the estuary, that location strongly suggests a sediment source in the Columbia, upstream of the Cowlitz River. Sediment gradations in this reach have varied only slightly since the eruption, indicating a common source, such as the 1980 mudflow. Sufficient data is not available to positively identify the current sediment source.

There was some deposition downstream of the Cowlitz River, particularly in December 1982 when deposition threatened to interfere with navigation. The December 1982 deposition corresponded with a large storm in the Toutle watershed and was originally thought to have been caused by Cowlitz River sediment discharges. An evaluation of the gradations of the depositon and sediment discharges indicated the Columbia deposits were noticably coarser than the suspended-sediment discharges. The Columbia deposits were also much coarser than the sediment deposited in the sump at the mouth of the Cowlitz River during the same December 1982 time period. This sump should have trapped coarse sediments if they were part of the Cowlitz River bedload. The gradation of the December 1982 Columbia deposits is very similiar to other bed gradations measured between Columbia River Miles 66 and 72 since the 1980 eruption. The consistently coarser gradation of Columbia bed material as compared to the Cowlitz River sediment discharges, indicate the Cowlitz is not a significant factor in Lower Dobelbower Bar deposition.

Deposition Forecast: As indicated by the previous two sections, there has not been a significant increase in overall Columbia River deposition since the 1980 eruption. Some increase was observed near the Cowlitz/Columbia confluence but the available data suggests some cause other than the

post-eruption Cowlitz River sediment discharges. Therefore no significant increase in Columbia River deposition due to the avalanche erosion is anticipated to occur over the next 50 years. The depositional processes are not well defined and extreme flood events or mudflows could cause unforeseen deposition.

CONCLUSIONS

Geomorphic processes occuring in the debris avalanche stream channels are causing a gradual decline in erosion rates. This forecast predicts the erosion rates will decline from the current 18-23 mcy/yr range to about 13 mcy/yr by the turn of the century and to nearly 6 mcy/yr in 50 years. The total erosion during the next 50 years is expected to be 550 mcy. These high yields are due to the abundant supply of water including extreme storm event sediment and the long-term destabilizing impacts of volcanic caused mudflows. As erosion rates decline, the estimates of deposition in the Cowlitz River fall from 9 mcy in WY 1986 to 2 mcy in WY 2000 and to 1 mcy in WY 2035. The expected long-term deposition is more severe than earlier estimates with a 50 year total of 110 mcy, due to the continuous delivery of coarse sands and gravels. Those classes make up only 10% of the expected sediment yields, but cause 60% of the expected Cowlitz River deposition. Conversely, Columbia River deposition is expected to be insignificant because of the deposition of coarse sediment in the Cowlitz River and the inability of the Cowlitz River to move this coarse material.

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CONSULTANTS' COMMENTS

ON

TOUTLE AND COWLITZ RIVERS SEDIMENT ANALYSIS

May 24, 1985

The consultants consider that the NPP staff has responded effectively to our comments at the March 1985 meeting and have performed a highly professional analysis of probable future sediment erosion, transport, and deposition.

Sediment Yield Curve

1. We have carefully reviewed the quantities and over-all results of the District's analysis and consider that a degree of conservatism is warranted in the estimate of avalanche yield over 50 years for the following reasons:

a. Even though the monitoring has been at a high quality and quantity level, hydrologic events during the 5 years since the eruption have not yielded a good sampling of what can occur in the future.

b. Modeling studies since our last meeting indicate that much more incision into the avalanche can occur than was previously considred.

c. The possible sequences of channel degradation, widening and migration within the avalanche area are many and are difficult to predict. Such changes can greatly influence the rate by which erosion decreases with time.

2. As a consequence of this concern, the concultants suggest that the 50-year sediment yield of 440 mcy may be increased by 25 to 50 percent.

3. The primary change is an increase in the erosion downstream of Coldwater Creek because of the increased ability to incise as demonstrated by the model, and availability of material. The suggested yield increase depletes a total of only 15 percent of the avalanche material in 50 years, including 25 percent of the material in the Elk Rock-Coldwater reach.

Toutle River Gravels

1. Accumulation of gravels in Toutle River:

a. The avalanche sediments contain modest amounts of gravel. Sediment in the gravel sizes has been trapped in bedload samplers by the U. S. Geological Survey personnel in the Toutle River, showing that such materials are moved even under modest flows. The transport rate of gravels in the Toutle River is expected to be low. However, further investigations should be undertaken to determine if gravel deposits pose problems in the river.

b. These investigations should start with the review of size distribution of samples of bed sediment in the Toutle River to determine the amount of gravel present. It is of interest to determine whether such sediment derives from the bank or is brought in by the flows.

c. Another part of the investigation is to determine the competence of the flows to move sediment of various sizes. To do this, the bed shear stresses at various stations along the river should be determined for various expected flows. These stresses should be compared with the Shields shear stresses for the several sizes of gravel to determine if they will be moved by the flows. This would give an indication of what grain sizes would move in the various reaches of the river.

d. As bedload samples become available, they should be analyzed to determine rates of movement of gravel.

2. The above investigations should indicate if accumulations of gravel will form and if they pose problems.

<u>Analysis of Present and Future Sediment Problems in the Cowlitz River</u>

1. The analysis of the Cowlitz system downstream of the Toutle River has been reviewed utilizing:

a. Data base
b. Dredging requirements.
c. Hydraulic conditions.
d. Observed responses of the system.
e. HEC 2 and HEC 6 modeling.

2. The analysis has resulted in an adequate understanding of the physical processes active in the system and the system's response to these processes.

3. The conclusions of the Consultants to the present analysis are:

a. Within the first five-mile reach downstream of the confluence, it is anticipated that aggradation caused by overloading the river with coarse sand and some gravel will require periodic dredging.

The quantities that should be dredged are highly dependent upon sediment control measures implemented in the Toutle River and climatic and hydrologic conditions in the watershed.

b. Assuming implementation of adequate sediment control measures in the Toutle River, it is concluded that no significant sediment problems should develop in the remainder of the Cowlitz River or in the Columbia River unless impaired by major flood and related episodic events.

Leo R. Beard — June 20, 1985
Leo R. Beard — Date

Daryl Simons — June 18, 1985
Daryl Simons — Date

Vito A. Vanoni — Jun. 13, 1985
Vito A. Vanoni — Date

APPENDIX B

MEASURE COST SUMMARY

INTRODUCTION

Purpose

This appendix contains cost data for each of the measures addressed in this document. The cost figures in tables B-1 and B-2 summarize the following information:

°average annual and total cost for three levels of dredging on two rivers

°the same costs for five spillway heights, two methods of construction on two rivers

°the same costs for four staging options

Table B-3 provides average annual and total costs for levee improvements at Longview, Kelso, Lexington and Castle Rock. Table B-4 provides cost flows for the years 1986-2035 for the dredging plus minimal levees at Kelso, Lexington, and Castle Rock. Table B-5 provides annual volumes for base dredging. Table B-6 summarizes the total project cost. Table B-7 summarizes the cost flow for years 1986-2035 for the NED Plan - a 125-foot spillway SRS with greater than base dredging and a minimal levee improvement at Kelso. Table B-8 provides a summary of yearly dredging volumes fore base-plus dredging. Table B-9 provides the total SRS alternative project cost. Table B-10 summarizes the cost flow for years 1986-2035 for a 100-foot spillway MSRS to be raised to 125 feet, with greater than base dredging and a minimal levee at Kelso. Table B-11 provides the total project cost for this alternative. Table B-12 summarizes yearly dredging volumes for intermediate dredging.

Chart B-1 indicates sediment volume passed or dredged for three levees of dredging and the total average annual costs for the required dredging. Charts

B-2 and B-3 provide total and average annual costs for the dredging options on Toutle and Cowlitz River respectively. Chart B-4 indicates these same costs for Toutle and Cowlitz dredging and a 1/2 E budget. Chart B-5 shows sediment volumes trapped, passed or dredged for five sizes of SRS. Chart B-6 provides costs for the five SRS sizes studied (Cowlitz River dredging). Chart B-7 breaks down the costs for the selected SRS (El. 940 foot spillway) into the major components for Cowlitz River dredging. Chart B-8 provides costs for the SRS sizes with Toutle River dredging. Chart B-9 provides costs for a 1/2 E budget and the SRS sizes studied (Cowlitz River dredging). Chart B-10 shows the effect that design for a 1 1/2 E budget and Toutle dredging would have on the cost for a SRS. Chart B-11 compares the cost flows for dredging and a SRS with spillway at El. 940. Chart B-12 provides costs for a MSRS with initial spillway height of 100 feet, later raised to 125 feet. Chart B-13 shows a component cost summary for the best dredging/levee alternative - base dredging and minimal levee improvements at Kelso, Lexington, and Castle Rock. Chart B-14 provides a component cost summary for the NED plan - an SRS with spillway elevation 940 feet with base-plus dredging and a minimal levee improvement at Kelso. Chart B-15 compares the cost flows for base dredging and levee improvement at Kelso, Lexington, and Castle Rock with cost flows for an SRS with spillway at El. 940, base-plus dredging, and levee improvement at Kelso.

DECISION DOCUMENT COST MATRIX

AVERAGE ANNUAL COST IN MILLIONS OF DOLLARS

BUDGET ANALYZED

	DREDGE 1/ LOCATION	½'E' BUDGET SPILLWAY HT. (FT)					'E' BUDGET SPILLWAY HT. (FT)					1½'E' BUDGET SPILLWAY HT. (FT)		
		50	85	100	125	150	50	100	125	150	200	(100')	OPTIMUM FOR 'E' (125')	(150')
SRS														
EMBANKMENT	T	6.82	6.78	6.50	6.59	7.67	12.06	9.45	8.62	9.09	11.62	14.19	10.84	10.63
EMBANKMENT	C	6.45	6.36	6.17	6.30	7.29	11.79	8.76	8.15	8.70	11.25	18.47	11.90	10.40
RCC	T	7.01	7.63	7.56	7.87		12.09	10.35	9.86	10.24	13.32		12.06	
RCC	C	6.56	7.10	7.13	7.58		11.89	9.65	9.40	9.86	12.95		13.12	

		STAGING ALTERNATIVE			
		I	II	III	IV
STAGED SRS					
EMBANKMENT	T	9.86	9.53	9.17	8.97
EMBANKMENT	C	9.16	8.98	8.61	8.45

		½'E' BUDGET	'E' BUDGET	1½'E' BUDGET
DREDGING				
BASE	T	3.89	13.08	19.00
BASE	C	3.38	13.90	
INTERMEDIATE	T	5.21	16.50	26.06
INTERMEDIATE	C	4.73	20.51	
MAXIMUM	T		22.08	
MAXIMUM	C		26.13	

NOTE 1/T = EMPHASIS ON TOUTLE DREDGING

C = EMPHASIS ON COWLITZ DREDGING

2/COSTS DO NOT INCLUDE LEVEE IMPROVEMENTS

TABLE B-1

DECISION DOCUMENT COST MATRIX

TOTAL COST IN MILLIONS OF DOLLARS

BUDGET ANALYZED

	DREDGE 1/ LOCATION	½'E' BUDGET SPILLWAY HT. (FT) 50	85	100	125	150	'E' BUDGET SPILLWAY HT. (FT) 50	100	125	150	200	1½'E' BUDGET SPILLWAY HT. (FT) (100')	OPTIMUM FOR 'E' (125')	(150')
SRS														
EMBANKMENT	T	179.64	176.20	160.99	131.48	113.87	318.76	239.23	206.34	184.18	169.88	356.13	276.04 3	248.48
EMBANKMENT	C	170.45	166.36	152.00	125.27	109.14	380.40	233.51	201.88	177.77	165.16	593.50	402.51 3	293.69
RCC	T	178.04	181.90	170.29	146.48		312.56	245.23	217.34	195.18	191.88		286.04 3	
RCC	C	164.45	170.36	160.00	140.27		374.40	239.33	213.58	188.77	187.16		412.51 3	
DREDGING														
BASE	T			148.21						346.64			526.59	
BASE	C			140.28						475.32				
INTERMEDIATE	T			190.26						476.13			748.10	
INTERMEDIATE	C			204.45						662.13				
MAXIMUM	T									668.98				
MAXIMUM	C									793.59				

STAGED SRS

	DREDGE 1/ LOCATION	STAGING ALTERNATIVE I	II	III	IV
EMBANKMENT	T	245.23	232.31	210.33	206.67
EMBANKMENT	C	241.41	231.66	206.60	203.12

NOTE 1/T = EMPHASIS ON TOUTLE DREDGING
C = EMPHASIS ON COWLITZ DREDGING
2/COSTS DO NOT INCLUDE LEVEE IMPROVEMENTS
REVISED 8/27/85 DELETED DIRTY WATER ADJUSTMENTS

TABLE B-2

TABLE B-3

LEVEE COSTS

(Average Annual)

($1,000)

Levee Option	Longview	Kelso	Lexington	Castle Rock
Minimal	$ 0	$ 140	$ 100	$ 30
Medium	2,270	1,390 1/	350	270
High	2,630	1,930 1/	520	380

LEVEE COSTS

(Total)

($1,000)

Levee Option	Longview	Kelso	Lexington	Castle Rock
Minimal	$ 0	$1,870	$ 1,340	$ 380
Medium	33,500	20,370 1/	5,200	4,000
High	38,800	28,270 1/	7,700	5,700

1/ Kelso medium and high levee raise costs include the minimal levee raise in-place in 1987.

TABLE B-4

COST FLOW ($M)

PLAN -- BASE DREDGING + LEVEE (KL,LX,CR)

	SRS					DREDGING			LEVEE				OTHER		
	CONST	MONITOR	RE	RELOC	MITIGAT	COST	RE	MIT	COST	RE	O&M	REVET	REHAB	MON	TOTAL
1986	0.00	0.00	0.00	0.00	0.00	19.38	0.58	2.06	0.00	2.00	0.00	5.23	0.10	1.80	31.18
1987	0.00	0.00	0.00	0.00	0.00	15.49	0.33	1.78	1.48	0.00	0.00	3.4[illegible]	0.10	1.00	23.58
1988	0.00	0.00	0.00	0.00	0.00	15.31	0.33	1.76	0.00	0.00	0.04	0.00	0.10	1.00	18.54
1989	0.00	0.00	0.00	0.00	0.00	14.79	0.32	1.70	0.00	0.00	0.04	0.00	0.10	1.00	17.95
1990	0.00	0.00	0.00	0.00	0.00	14.44	0.32	1.66	0.00	0.00	0.04	0.00	0.10	1.00	17.56
1991	0.00	0.00	0.00	0.00	0.00	13.92	0.32	1.60	0.00	0.00	0.04	0.00	0.10	1.00	16.98
1992	0.00	0.00	0.00	0.00	0.00	12.18	0.15	1.40	0.00	0.00	0.04	0.00	0.10	1.00	14.87
1993	0.00	0.00	0.00	0.00	0.00	9.92	0.12	1.14	0.00	0.00	0.04	0.00	0.10	1.00	12.[illegible]
1994	0.00	0.00	0.00	0.00	0.00	9.33	0.16	1.06	0.00	0.00	0.04	0.00	0.10	1.00	11.69
1995	0.00	0.00	0.00	0.00	0.00	10.53	0.59	0.98	0.00	0.00	0.04	0.75	0.10	1.00	13.99
1996	0.00	0.00	0.00	0.00	0.00	9.67	0.54	0.90	0.00	0.00	0.04	0.00	0.10	1.00	12.25
1997	0.00	0.00	0.00	0.00	0.00	9.03	0.50	0.84	0.00	0.00	0.04	0.00	0.10	1.00	11.51
1998	0.00	0.00	0.00	0.00	0.00	8.17	0.46	0.76	0.00	0.00	0.04	0.00	0.10	1.00	10.53
1999	0.00	0.00	0.00	0.00	0.00	7.52	0.42	0.70	0.00	0.00	0.04	0.00	0.10	1.00	9.78
2000	0.00	0.00	0.00	0.00	0.00	6.01	0.36	0.51	0.00	0.00	0.04	0.00	0.20	1.00	8.11
2001	0.00	0.00	0.00	0.00	0.00	3.00	0.20	0.21	0.00	0.00	0.04	0.00	0.20	1.00	4.66
2002	0.00	0.00	0.00	0.00	0.00	2.71	0.18	0.19	0.00	0.00	0.04	0.00	0.20	1.00	4.32
2003	0.00	0.00	0.00	0.00	0.00	2.41	0.16	0.17	0.00	0.00	0.04	0.00	0.20	1.00	3.98
2004	0.00	0.00	0.00	0.00	0.00	2.41	0.16	0.17	0.00	0.00	0.04	0.00	0.20	1.00	3.98
2005	0.00	0.00	0.00	0.00	0.00	2.27	0.15	0.15	0.00	0.00	0.04	0.00	0.20	1.00	3.82
2006	0.00	0.00	0.00	0.00	0.00	2.14	0.14	0.15	0.00	0.00	0.04	0.00	0.20	1.00	3.67
2007	0.00	0.00	0.00	0.00	0.00	2.00	0.13	0.14	0.00	0.00	0.04	0.00	0.20	1.00	3.51
2008	0.00	0.00	0.00	0.00	0.00	2.16	0.12	0.13	0.00	0.00	0.04	0.00	0.20	1.00	3.65
2009	0.00	0.00	0.00	0.00	0.00	2.16	0.12	0.13	0.00	0.00	0.04	0.00	0.20	1.00	3.65
2010	0.00	0.00	0.00	0.00	0.00	1.83	0.10	0.11	0.00	0.00	0.04	0.00	0.20	1.00	3.28
2011	0.00	0.00	0.00	0.00	0.00	1.83	0.10	0.11	0.00	0.00	0.04	0.00	0.20	1.00	3.28
2012	0.00	0.00	0.00	0.00	0.00	1.66	0.09	0.10	0.00	0.00	0.04	0.00	0.20	1.00	3.10
2013	0.00	0.00	0.00	0.00	0.00	1.66	0.09	0.10	0.00	0.00	0.04	0.00	0.20	1.00	3.10
2014	0.00	0.00	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.04	0.00	0.20	1.00	3.23
2015	0.00	0.00	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.04	0.00	0.20	1.00	3.23
2016	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.20	1.00	3.04
2017	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.20	1.00	3.04
2018	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.20	1.00	3.04
2019	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.20	1.00	3.04
2020	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.14
2021	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.14
2022	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.14
2023	0.00	0.00	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.14
2024	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2025	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2026	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2027	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2028	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2029	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2030	0.00	0.00	0.00	0.00	0.00	2.09	0.09	0.09	0.00	0.00	0.04	0.00	0.30	1.00	3.61
2031	0.00	0.00	0.00	0.00	0.00	1.86	0.08	0.08	0.00	0.00	0.04	0.00	0.30	1.00	3.35
2032	0.00	0.00	0.00	0.00	0.00	1.86	0.08	0.08	0.00	0.00	0.04	0.00	0.30	1.00	3.35
2033	0.00	0.00	0.00	0.00	0.00	1.86	0.08	0.08	0.00	0.00	0.04	0.00	0.30	1.00	3.35
2034	0.00	0.00	0.00	0.00	0.00	1.86	0.08	0.08	0.00	0.00	0.04	0.00	0.30	1.00	3.35
2035	0.00	0.00	0.00	0.00	0.00	1.86	0.08	0.08	0.00	0.00	0.04	0.00	0.30	1.00	3.35
															352.10

TABLE B-5

BASE DREDGING- TOUTLE RIVER INITIATED

YEAR	NF-1 MCY	TOUTLE SITES LT-3 MCY	LT-1 MCY	SUBTOTAL MCY	COWLITZ SITES RM 10-20 MCY	RM 0-10 MCY	SUBTOTAL MCY	TOTAL MCY
1986	3.0	4.5	1.5	9.0	2.0	0.6	2.6	11.6
1987	3.0	4.5	1.4	8.9			0.0	8.9
1988	3.0	4.5	1.3	8.8			0.0	8.8
1989	3.0	4.5	1.0	8.5			0.0	8.5
1990	3.0	4.5	0.8	8.3			0.0	8.3
1991	3.0	4.5	0.5	8.0			0.0	8.0
1992	4.0		3.0	7.0			0.0	7.0
1993	3.0		2.7	5.7			0.0	5.7
1994	5.3			5.3			0.0	5.3
1995	4.9			4.9			0.0	4.9
1996	4.5			4.5			0.0	4.5
1997	4.2			4.2			0.0	4.2
1998	3.8			3.8			0.0	3.8
1999	3.5			3.5			0.0	3.5
2000	1.8			1.8	1.2	0.3	1.5	3.3
2001				0.0	1.6	0.5	2.1	2.1
2002				0.0	1.5	0.4	1.9	1.9
2003				0.0	1.4	0.3	1.7	1.7
2004				0.0	1.4	0.3	1.7	1.7
2005				0.0	1.3	0.3	1.6	1.6
2006				0.0	1.2	0.3	1.5	1.5
2007				0.0	1.1	0.3	1.4	1.4
2008				0.0	1.0	0.3	1.3	1.3
2009				0.0	1.0	0.3	1.3	1.3
2010				0.0	0.9	0.2	1.1	1.1
2011				0.0	0.9	0.2	1.1	1.1
2012				0.0	0.8	0.2	1.0	1.0
2013				0.0	0.8	0.2	1.0	1.0
2014				0.0	0.8	0.2	1.0	1.0
2015				0.0	0.8	0.2	1.0	1.0
2016				0.0	0.7	0.2	0.9	0.9
2017				0.0	0.7	0.2	0.9	0.9
2018				0.0	0.7	0.2	0.9	0.9
2019				0.0	0.7	0.2	0.9	0.9
2020				0.0	0.7	0.2	0.9	0.9
2021				0.0	0.7	0.2	0.9	0.9
2022				0.0	0.7	0.2	0.9	0.9
2023				0.0	0.7	0.2	0.9	0.9
2024				0.0	0.7	0.2	0.9	0.9
2025				0.0	0.7	0.2	0.9	0.9
2026				0.0	0.7	0.2	0.9	0.9
2027				0.0	0.7	0.2	0.9	0.9
2028				0.0	0.7	0.2	0.9	0.9
2029				0.0	0.7	0.2	0.9	0.9
2030				0.0	0.7	0.2	0.9	0.9
2031				0.0	0.6	0.2	0.8	0.8
2032				0.0	0.6	0.2	0.8	0.8
2033				0.0	0.6	0.2	0.8	0.8
2034				0.0	0.6	0.2	0.8	0.8
2035				0.0	0.6	0.2	0.8	0.8
	53.0	27.0	12.2	92.2	33.2	9.1	42.3	134.5

TABLE B-6

TOTAL PROJECT COST

DREDGING-BASE CONDITION AND KL/LX/CR MINIMUM LEVEES

($000,000)

Total Project Cost

Dredging		276.29
Construction	244.47	
Real Estate	9.15	
Mitigation	22.67	
Levees		5.46
Construction	1.48	
Real Estate	2.06	
O&M	1.92	
Other		70.35
Disposal Site Rahab.	10.20	
Revetments	9.35	
D/S Monitoring	50.80	
TOTAL PROJECT COST		352.10

TABLE B-7

COST FLOW ($M)
PLAN -- SRS + DREDGING + LEVEE(KL)
(WITH INTERMEDIATE DREDGING)

	SRS					DREDGING			LEVEE			OTHER			
	CONST	MONITOR	RE	RELOC	MITIGAT	COST	RE	MIT	COST	RE	O&M	REVET	REHAB	MON	TOTA
1986	6.00	0.00	12.20	0.40	1.30	25.38	1.78	1.69	0.00	1.10	0.00	0.00	0.10	1.80	51.75
1987	17.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	17.84
1988	31.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	31.52
1989	9.70	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	9.82
1990	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1991	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1992	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1993	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1994	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1995	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1996	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1997	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1998	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1999	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
2000	0.10	0.10	0.00	0.00	0.00	2.84	0.17	0.18	0.00	0.00	0.02	0.00	0.10	1.00	4.51
2001	0.10	0.10	0.00	0.00	0.00	2.84	0.17	0.18	0.00	0.00	0.02	0.00	0.10	1.00	4.51
2002	0.10	0.10	0.00	0.00	0.00	2.87	0.15	0.16	0.00	0.00	0.02	0.00	0.10	1.00	4.49
2003	0.10	0.10	0.00	0.00	0.00	2.36	0.12	0.13	0.00	0.00	0.02	0.00	0.10	1.00	3.93
2004	0.10	0.10	0.00	0.00	0.00	2.36	0.12	0.13	0.00	0.00	0.02	0.00	0.10	1.00	3.93
2005	2.00	0.10	0.00	0.00	0.00	2.14	0.11	0.12	0.00	0.00	0.02	0.00	0.10	1.00	5.59
2006	0.10	0.10	0.00	0.00	0.00	1.97	0.10	0.11	0.00	0.00	0.02	0.00	0.10	1.00	3.50
2007	0.10	0.10	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.02	0.00	0.10	1.00	3.31
2008	0.10	0.10	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.02	0.00	0.10	1.00	3.31
2009	0.10	0.10	0.00	0.00	0.00	1.63	0.09	0.08	0.00	0.00	0.02	0.00	0.10	1.00	3.12
2010	2.00	0.10	0.00	0.00	0.00	1.46	0.08	0.08	0.00	0.00	0.02	0.00	0.20	1.00	4.92
2011	0.10	0.10	0.00	0.00	0.00	1.46	0.08	0.08	0.00	0.00	0.02	0.00	0.20	1.00	3.02
2012	0.10	0.10	0.00	0.00	0.00	1.07	0.05	0.06	0.00	0.00	0.02	0.00	0.20	1.00	2.60
2013	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2014	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2015	2.00	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.32
2016	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2017	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2018	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2019	0.10	0.10	0.00	0.00	0.00	0.90	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.42
2020	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2021	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2022	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2023	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2024	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2025	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2026	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2027	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2028	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2029	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2030	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2031	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2032	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2033	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.58
2034	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.53
2035	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.53
															231.06

TABLE B-8

ELEV. 940 TOUTLE SRS WITH BASE (+) DREDGING

YEAR	TOUTLE SITES NF-1 MCY	LT-3 MCY	LT-1 MCY	SUBTOTAL MCY	COWLITZ SITES RM 10-20 MCY	RM 0-10 MCY	SUBTOTAL MCY	TOTAL MCY
1986				0.0	10.8	6.1	16.9	16.9
1987				0.0			0.0	0.0
1988				0.0			0.0	0.0
1989				0.0			0.0	0.0
1990				0.0			0.0	0.0
1991				0.0			0.0	0.0
1992				0.0			0.0	0.0
1993				0.0			0.0	0.0
1994				0.0			0.0	0.0
1995				0.0			0.0	0.0
1996				0.0			0.0	0.0
1997				0.0			0.0	0.0
1998				0.0			0.0	0.0
1999				0.0			0.0	0.0
2000				0.0	1.4	0.4	1.8	1.8
2001				0.0	1.4	0.4	1.8	1.8
2002				0.0	1.3	0.3	1.6	1.6
2003				0.0	1.0	0.3	1.3	1.3
2004				0.0	1.0	0.3	1.3	1.3
2005				0.0	0.9	0.2	1.1	1.1
2006				0.0	0.8	0.2	1.0	1.0
2007				0.0	0.8	0.2	1.0	1.0
2008				0.0	0.7	0.2	0.9	0.9
2009				0.0	0.6	0.2	0.8	0.8
2010				0.0	0.6	0.2	0.8	0.8
2011				0.0	0.5	0.2	0.7	0.7
2012				0.0	0.4	0.1	0.5	0.5
2013				0.0	0.4	0.1	0.5	0.5
2014				0.0	0.4	0.1	0.5	0.5
2015				0.0	0.4	0.1	0.5	0.5
2016				0.0	0.4	0.1	0.5	0.5
2017				0.0	0.4	0.1	0.5	0.5
2018				0.0	0.4	0.1	0.5	0.5
2019				0.0	0.4	0.1	0.5	0.5
2020				0.0	0.4	0.1	0.5	0.5
2021				0.0	0.4	0.1	0.5	0.5
2022				0.0	0.4	0.1	0.5	0.5
2023				0.0	0.4	0.1	0.5	0.5
2024				0.0	0.4	0.1	0.5	0.5
2025				0.0	0.4	0.1	0.5	0.5
2026				0.0	0.4	0.1	0.5	0.5
2027				0.0	0.4	0.1	0.5	0.5
2028				0.0	0.4	0.1	0.5	0.5
2029				0.0	0.4	0.1	0.5	0.5
2030				0.0	0.4	0.1	0.5	0.5
2031				0.0	0.4	0.1	0.5	0.5
2032				0.0	0.4	0.1	0.5	0.5
2033				0.0	0.3	0.1	0.4	0.4
2034				0.0	0.3	0.1	0.4	0.4
2035				0.0	0.3	0.1	0.4	0.4
	0.0	0.0	0.0	0.0	31.1	11.6	42.7	42.7

TABLE B-9

TOTAL PROJECT COST

125-FOOT SRS WITH COWLITZ BASE-PLUS DREDGING AND KL MINIMUM LEVEE

($000,000)

<u>Total Project Cost</u>		
SRS		98.9
Construction	63.7	
O&M	16.1	
Monitoring	5.2	
Real Estate	12.2	
Relocation	0.4	
Mitigation	1.3	
Dredging		84.8
Construction	76.15	
Real Estate	4.32	
Mitigation	4.33	
Levee (KL Min. Levee)		2.8
Cost	0.74	
Real Estate	1.10	
O&M	0.96	
Other		44.6
Revetment	0.00	
Disposal Site Rehab.	6.80	
D/S Monitoring	37.80	
TOTAL PROJECT COST		231.1

TABLE B-10
COST FLOW ($M)
PLAN -- MSRS+ DREDGING + LEVEE(KL)
(INTERMEDIATE CONDITION)

	SRS					DREDGING			LEVEE			OTHER			
	CONST	MONITOR	RE	RELOC	MITIGAT	COST	RE	MIT	COST	RE	O&M	REVET	REHAB	MON	TOTAL
1986	6.[illegible]	0.00	12.20	0.40	1.30	22.81	1.61	1.58	0.00	1.10	0.00	0.00	0.13	1.80	48.91
1987	17.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.00	17.87
1988	30.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	30.52
1989	9.70	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	9.82
1990	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1991	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1992	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1993	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.22
1994	0.10	0.10	0.00	0.00	0.00	4.40	0.27	0.28	0.00	0.00	0.02	0.00	0.10	1.00	6.26
1995	0.25	0.10	0.00	0.00	0.00	7.32	0.37	0.39	0.00	0.00	0.02	0.00	0.10	1.00	9.26
1996	3.75	0.10	0.00	0.00	0.00	6.46	0.34	0.36	0.00	0.00	0.02	0.00	0.10	1.00	12.13
1997	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
1998	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
1999	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2000	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2001	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2002	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2003	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2004	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.32
2005	0.10	0.10	0.00	0.00	0.00	2.36	0.12	0.13	0.00	0.00	0.02	0.00	0.10	1.00	3.93
2006	0.10	0.10	0.00	0.00	0.00	1.97	0.10	0.11	0.00	0.00	0.02	0.00	0.10	1.00	3.50
2007	0.10	0.10	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.02	0.00	0.10	1.00	3.31
2008	0.10	0.10	0.00	0.00	0.00	1.80	0.09	0.10	0.00	0.00	0.02	0.00	0.10	1.00	3.31
2009	0.10	0.10	0.00	0.00	0.00	1.63	0.09	0.09	0.00	0.00	0.02	0.00	0.10	1.00	3.12
2010	2.00	0.10	0.00	0.00	0.00	1.46	0.08	0.08	0.00	0.00	0.02	0.00	0.20	1.00	4.94
2011	0.10	0.10	0.00	0.00	0.00	1.46	0.08	0.08	0.00	0.00	0.02	0.00	0.20	1.00	3.04
2012	0.10	0.10	0.00	0.00	0.00	1.63	0.06	0.07	0.00	0.00	0.02	0.00	0.20	1.00	3.19
2013	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2014	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2015	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2016	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2017	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2018	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2019	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2020	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2021	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2022	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2023	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2024	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	2.68
2025	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.20	1.00	4.58
2026	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2027	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2028	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2029	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2030	2.00	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	4.68
2031	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2032	0.10	0.10	0.00	0.00	0.00	1.16	0.05	0.05	0.00	0.00	0.02	0.00	0.30	1.00	2.78
2033	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.53
2034	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.53
2035	0.10	0.10	0.00	0.00	0.00	0.93	0.04	0.04	0.00	0.00	0.02	0.00	0.30	1.00	2.53
															234.05

TABLE B-11

TOTAL PROJECT COST

100' - 125' MSRS WITH COWLITZ DREDGING AND KL MIN LEVEE

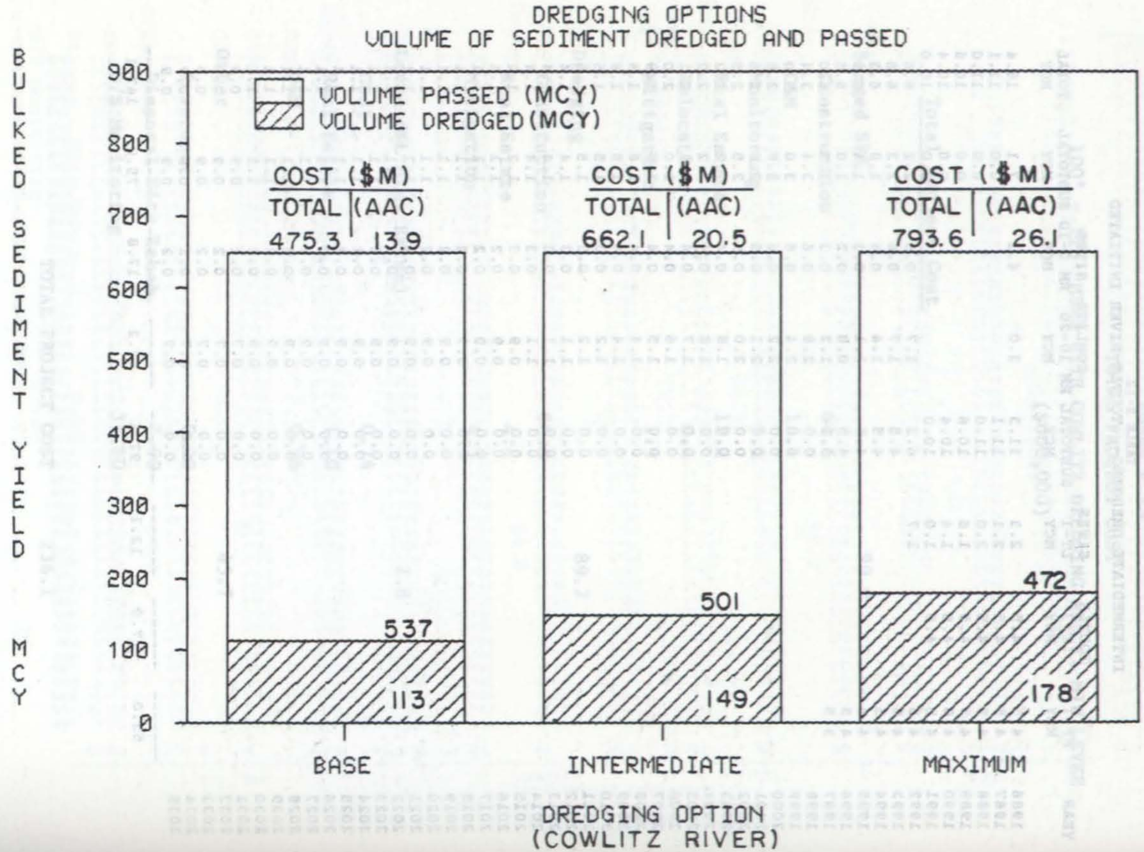
($000,000)

Total Project Cost		
Staged SRS		99.9
Construction	64.6	
O&M	16.1	
Monitoring	5.2	
Real Estate	12.2	
Relocation	0.4	
Mitigation	1.3	
Dredging		89.7
Construction	80.8	
Real Estate	4.4	
Mitigation	4.5	
Levee (KL Min. Raise)		2.8
Cost	0.74	
Real Estate	1.10	
O&M	0.96	
Other		43.7
Revetment	0.00	
Disposal Site Rehab.	7.90	
D/S Monitoring	35.80	
TOTAL PROJECT COST		236.1

TABLE B-12

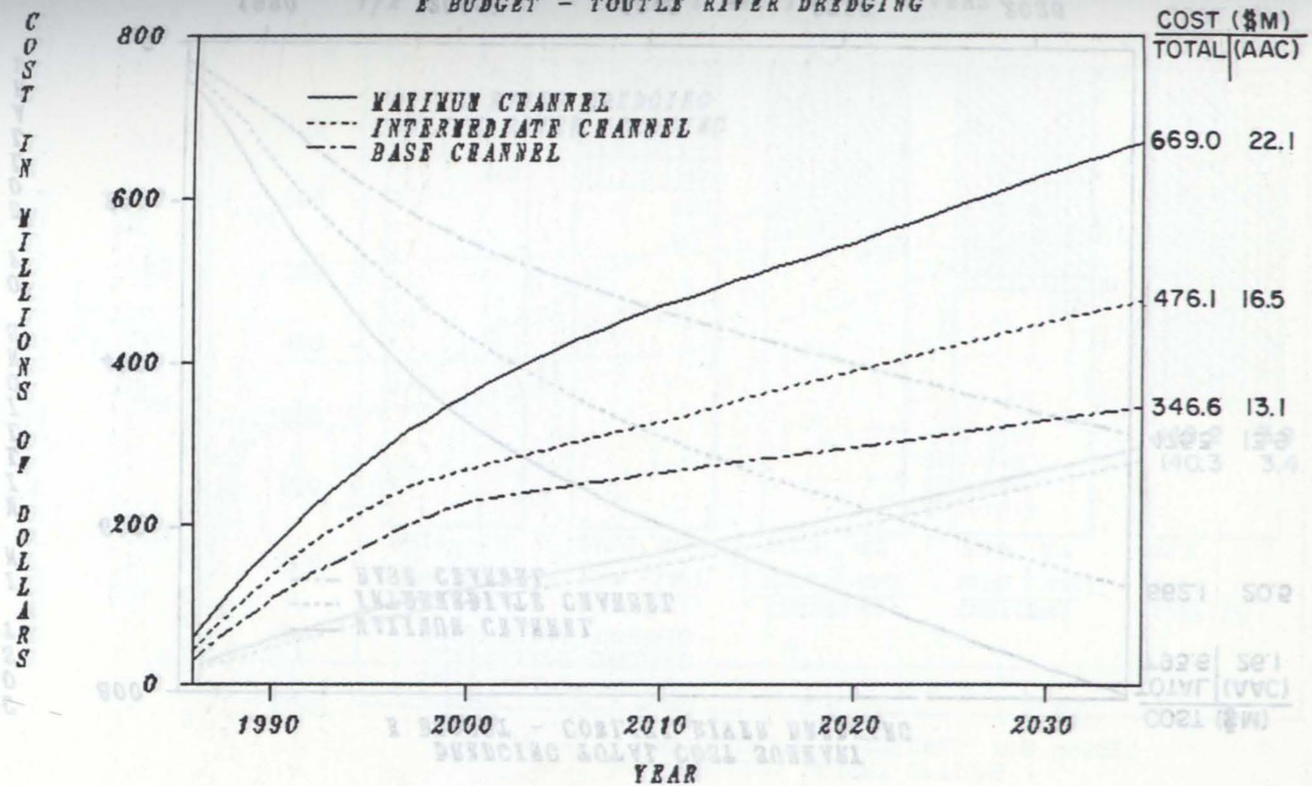
INTERMEDIATE DREDGING- TOUTLE RIVER INITIATED

YEAR	NF-1 MCY	TOUTLE LT-3 MCY	SITES LT-1 MCY	SUBTOTAL MCY	COWLITZ RM 10-20 MCY	SITES RM 0-10 MCY	SUBTOTAL MCY	TOTAL MCY
1986	4.5	4.5	2.3	11.3	3.0	4.1	7.1	18.4
1987	4.5	4.5	2.1	11.1			0.0	11.1
1988	4.5	4.5	2.0	11.0			0.0	11.0
1989	4.5	4.5	1.6	10.6			0.0	10.6
1990	4.5	4.5	1.4	10.4			0.0	10.4
1991	4.5	4.5	1.0	10.0			0.0	10.0
1992	4.5		1.7	6.2	1.7	0.5	2.2	8.4
1993	4.5			4.5	1.7	0.6	2.3	6.8
1994	4.5			4.5	1.4	0.4	1.8	6.3
1995	4.5			4.5	1.1	0.3	1.4	5.9
1996	4.5			4.5	0.8	0.2	1.0	5.5
1997	3.5			3.5	1.2	0.3	1.5	5.0
1998				0.0	2.8	0.6	3.4	3.4
1999				0.0	2.4	0.6	3.0	3.0
2000				0.0	2.2	0.6	2.8	2.8
2001				0.0	2.1	0.5	2.6	2.6
2002				0.0	2.0	0.5	2.5	2.5
2003				0.0	1.8	0.4	2.2	2.2
2004				0.0	1.8	0.4	2.2	2.2
2005				0.0	1.7	0.4	2.1	2.1
2006				0.0	1.6	0.4	2.0	2.0
2007				0.0	1.5	0.4	1.9	1.9
2008				0.0	1.4	0.4	1.8	1.8
2009				0.0	1.4	0.4	1.8	1.8
2010				0.0	1.2	0.3	1.5	1.5
2011				0.0	1.2	0.3	1.5	1.5
2012				0.0	1.1	0.3	1.4	1.4
2013				0.0	1.1	0.3	1.4	1.4
2014				0.0	1.1	0.3	1.4	1.4
2015				0.0	0.9	0.3	1.2	1.2
2016				0.0	0.9	0.2	1.1	1.1
2017				0.0	0.9	0.2	1.1	1.1
2018				0.0	0.9	0.2	1.1	1.1
2019				0.0	0.9	0.2	1.1	1.1
2020				0.0	0.9	0.2	1.1	1.1
2021				0.0	0.9	0.2	1.1	1.1
2022				0.0	0.9	0.2	1.1	1.1
2023				0.0	0.9	0.2	1.1	1.1
2024				0.0	0.9	0.2	1.1	1.1
2025				0.0	0.9	0.2	1.1	1.1
2026				0.0	0.9	0.2	1.1	1.1
2027				0.0	0.9	0.2	1.1	1.1
2028				0.0	0.9	0.2	1.1	1.1
2029				0.0	0.9	0.2	1.1	1.1
2030				0.0	0.9	0.2	1.1	1.1
2031				0.0	0.7	0.2	0.9	0.9
2032				0.0	0.7	0.2	0.9	0.9
2033				0.0	0.7	0.2	0.9	0.9
2034				0.0	0.7	0.2	0.9	0.9
2035				0.0	0.7	0.2	0.9	0.9
	53.0	27.0	12.1	92.1	57.2	17.8	75.0	167.1



DREDGING OPTIONS
VOLUME OF SEDIMENT DREDGED AND PASSED
BULKED SEDIMENT YIELD MCY
VOLUME PASSED (MCY)
VOLUME DREDGED (MCY)
COST ($M)
TOTAL (AAC)
475.3 13.9
COST ($M)
TOTAL (AAC)
662.1 20.5
COST ($M)
TOTAL (AAC)
793.6 26.1
0
100
200
300
400
500
600
700
800
900
537
113
501
149
472
178
BASE
INTERMEDIATE
MAXIMUM
DREDGING OPTION
(COWLITZ RIVER)

DREDGING TOTAL COST SUMMARY
E BUDGET - TOUTLE RIVER DREDGING



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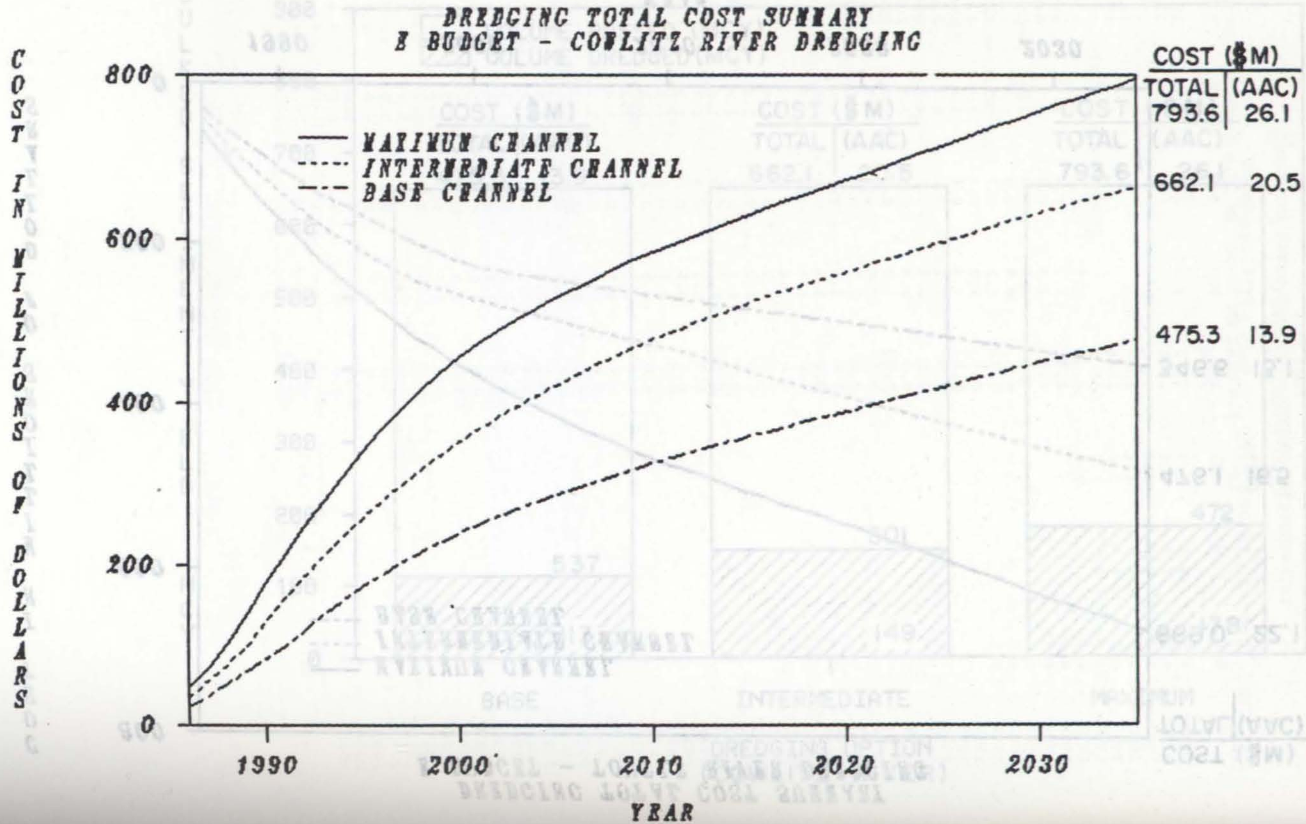
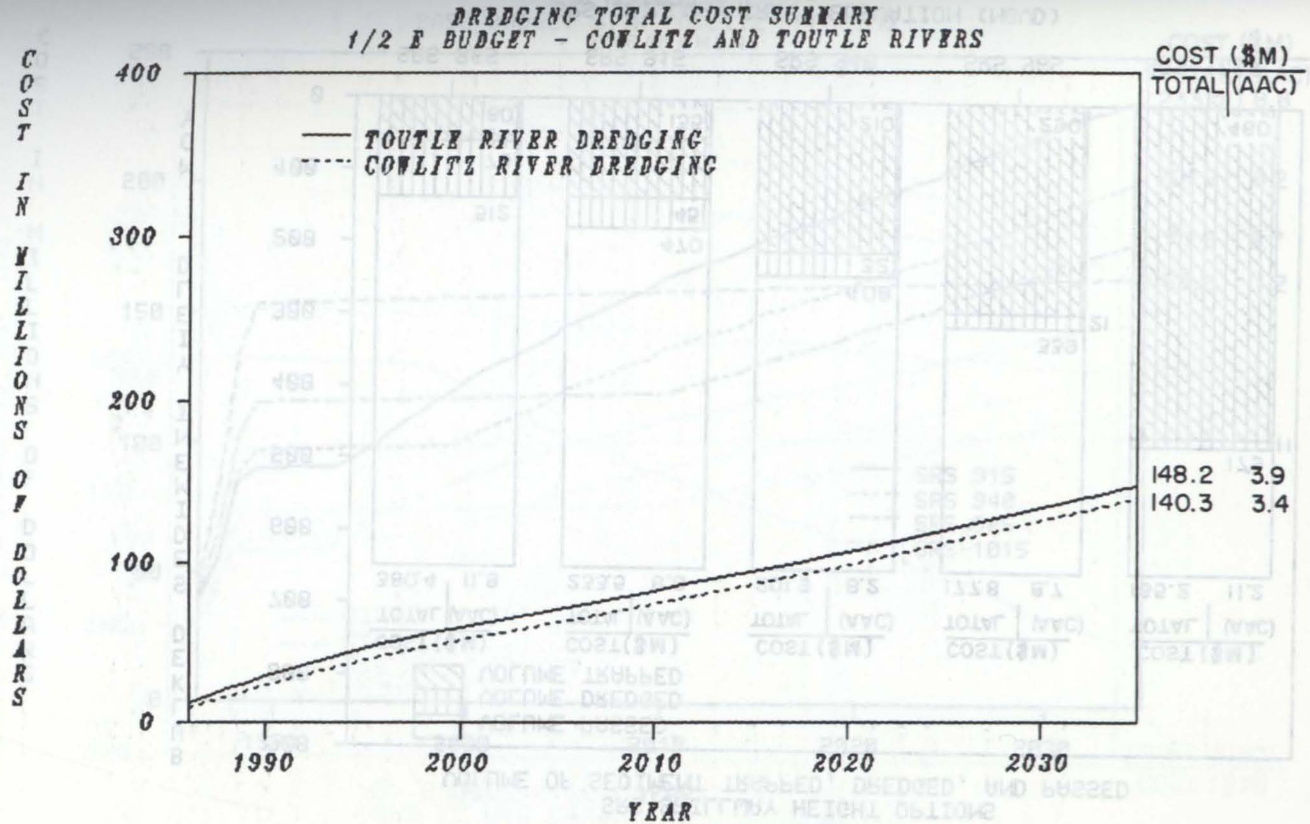
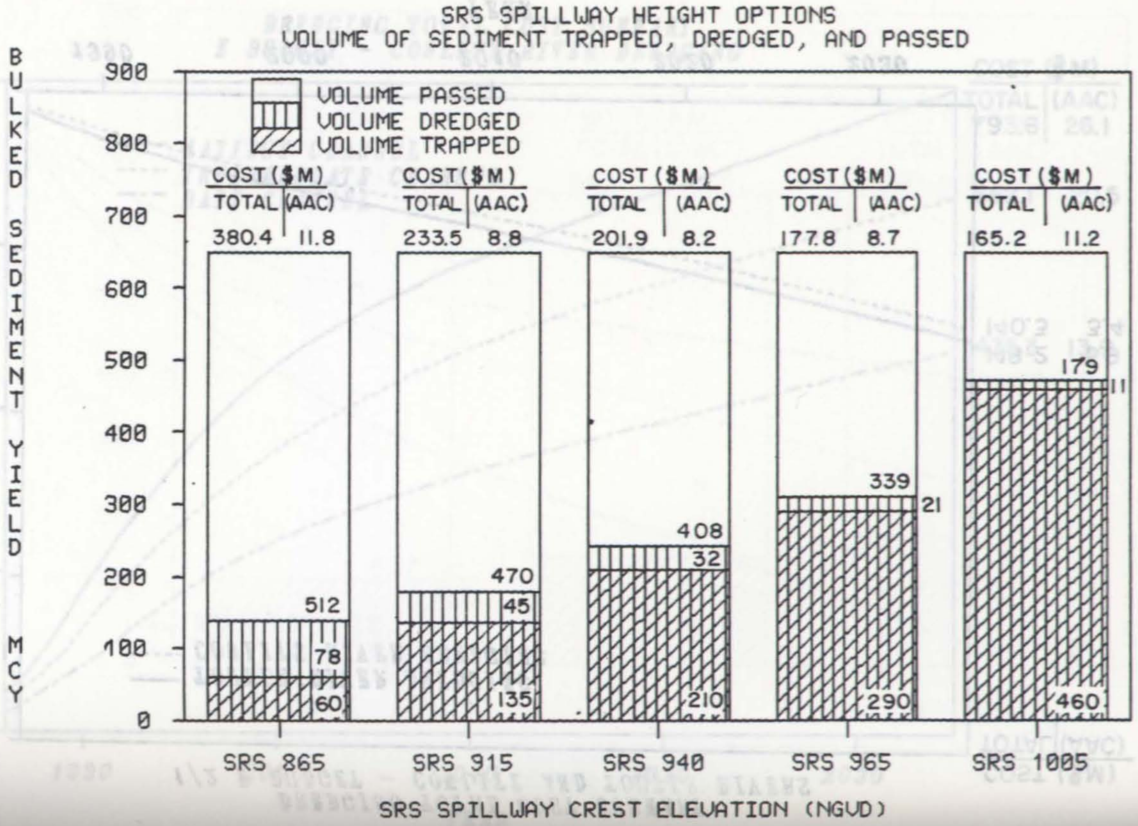
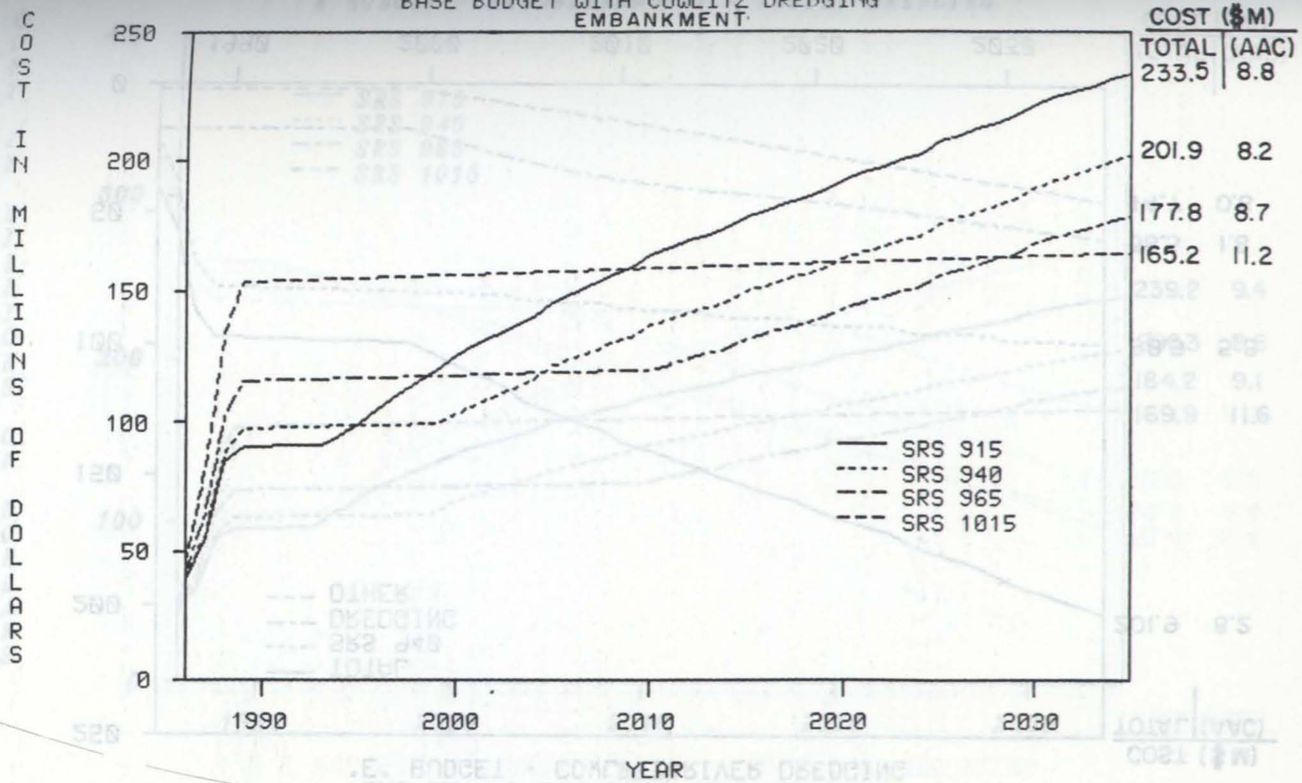
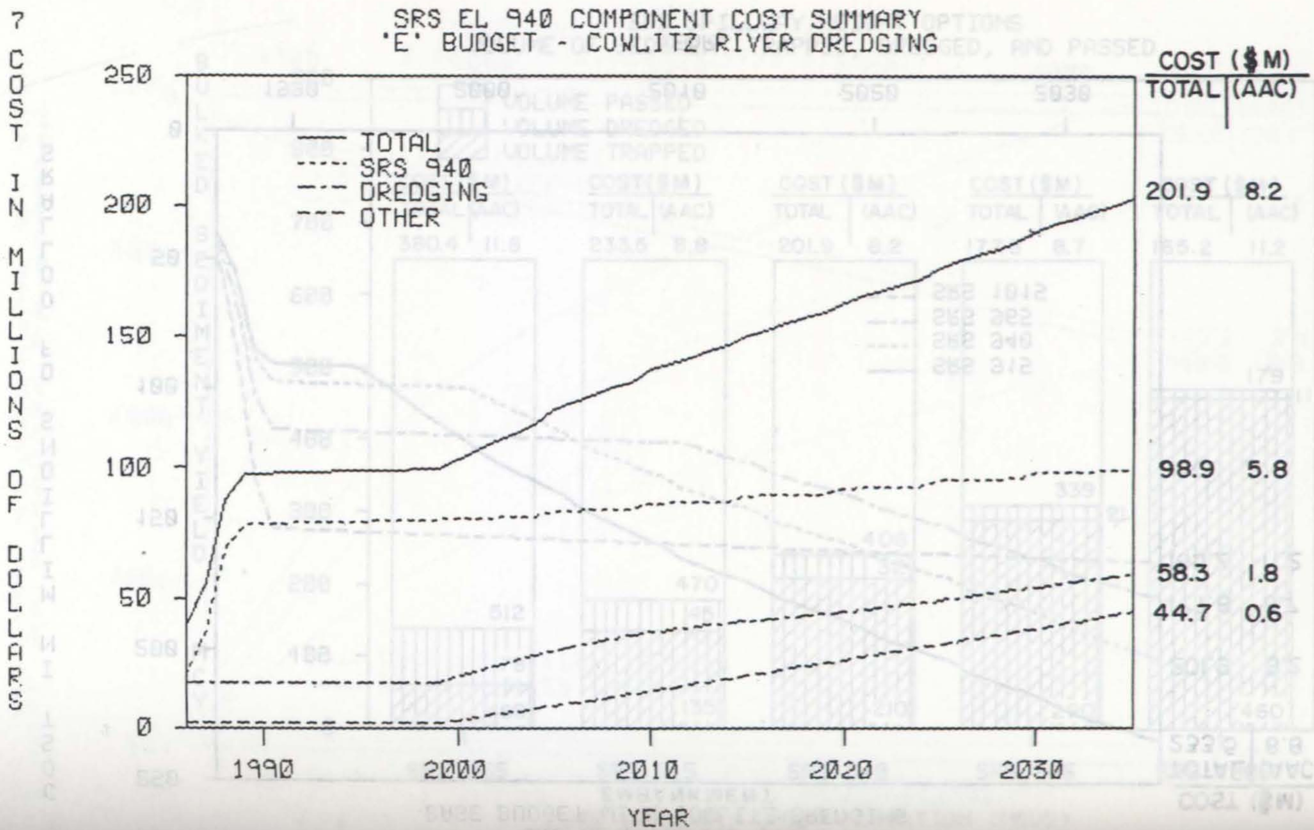

DREDGING TOTAL COST SUMMARY
E BUDGET - COWLITZ RIVER DREDGING
COST IN MILLIONS OF DOLLARS
800
600
400
200
0
MAXIMUM CHANNEL
INTERMEDIATE CHANNEL
BASE CHANNEL
1990
2000
2010
2020
2030
YEAR
COST ($M)
TOTAL (AAC)
793.6 26.1
662.1 20.5
475.3 13.9


DREDGING TOTAL COST SUMMARY
1/2 E BUDGET - COWLITZ AND TOUTLE RIVERS
COST IN MILLIONS OF DOLLARS
400
300
200
100
0
TOUTLE RIVER DREDGING
COWLITZ RIVER DREDGING
1990
2000
2010
2020
2030
YEAR
COST ($M)
TOTAL (AAC)
148.2 3.9
140.3 3.4


SRS SPILLWAY HEIGHT OPTIONS
VOLUME OF SEDIMENT TRAPPED, DREDGED, AND PASSED
BULKED SEDIMENT YIELD MCY
VOLUME PASSED
VOLUME DREDGED
VOLUME TRAPPED
COST ($M) TOTAL (AAC) 380.4 11.8
COST ($M) TOTAL (AAC) 233.5 8.8
COST ($M) TOTAL (AAC) 201.9 8.2
COST ($M) TOTAL (AAC) 177.8 8.7
COST ($M) TOTAL (AAC) 165.2 11.2
512
78
60
470
45
135
408
32
210
339
21
290
179
11
460
0
100
200
300
400
500
600
700
800
900
SRS 865
SRS 915
SRS 940
SRS 965
SRS 1005
SRS SPILLWAY CREST ELEVATION (NGVD)

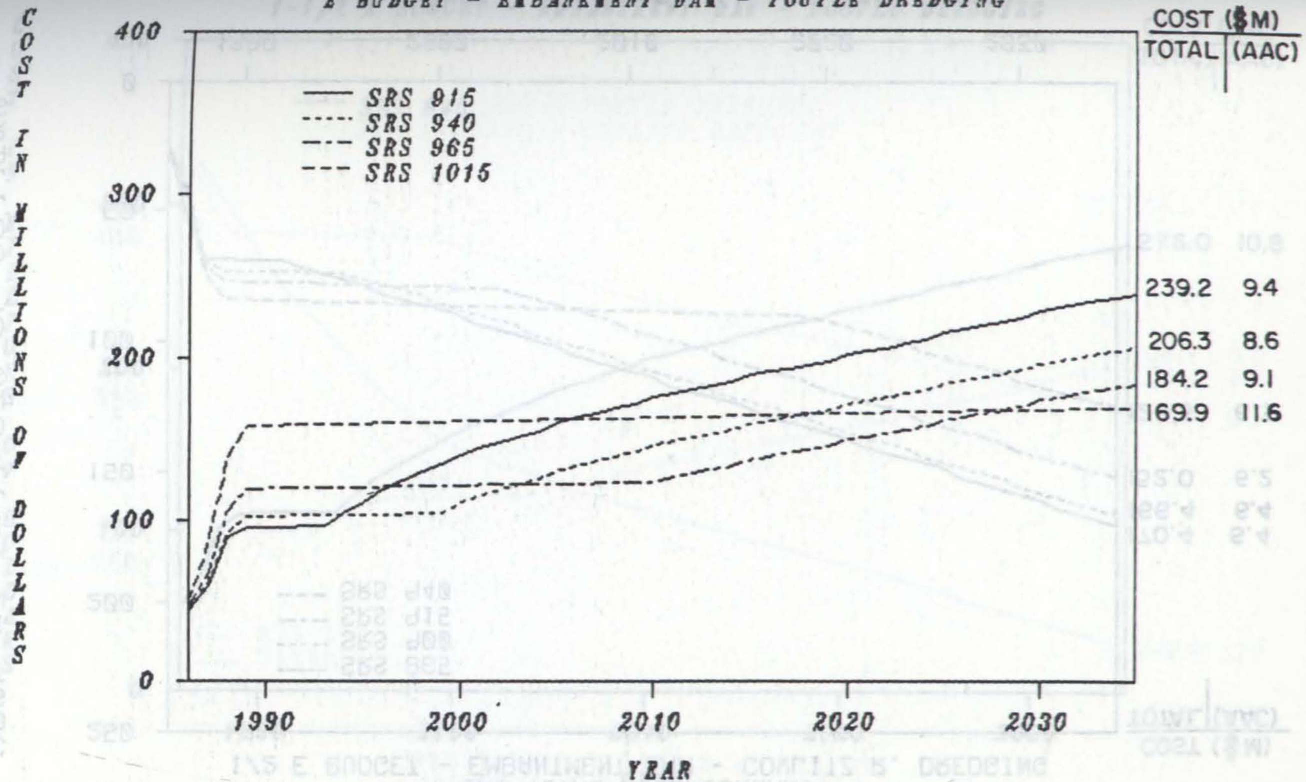
SRS ALTERNATIVE COSTS
BASE BUDGET WITH COWLITZ DREDGING
EMBANKMENT

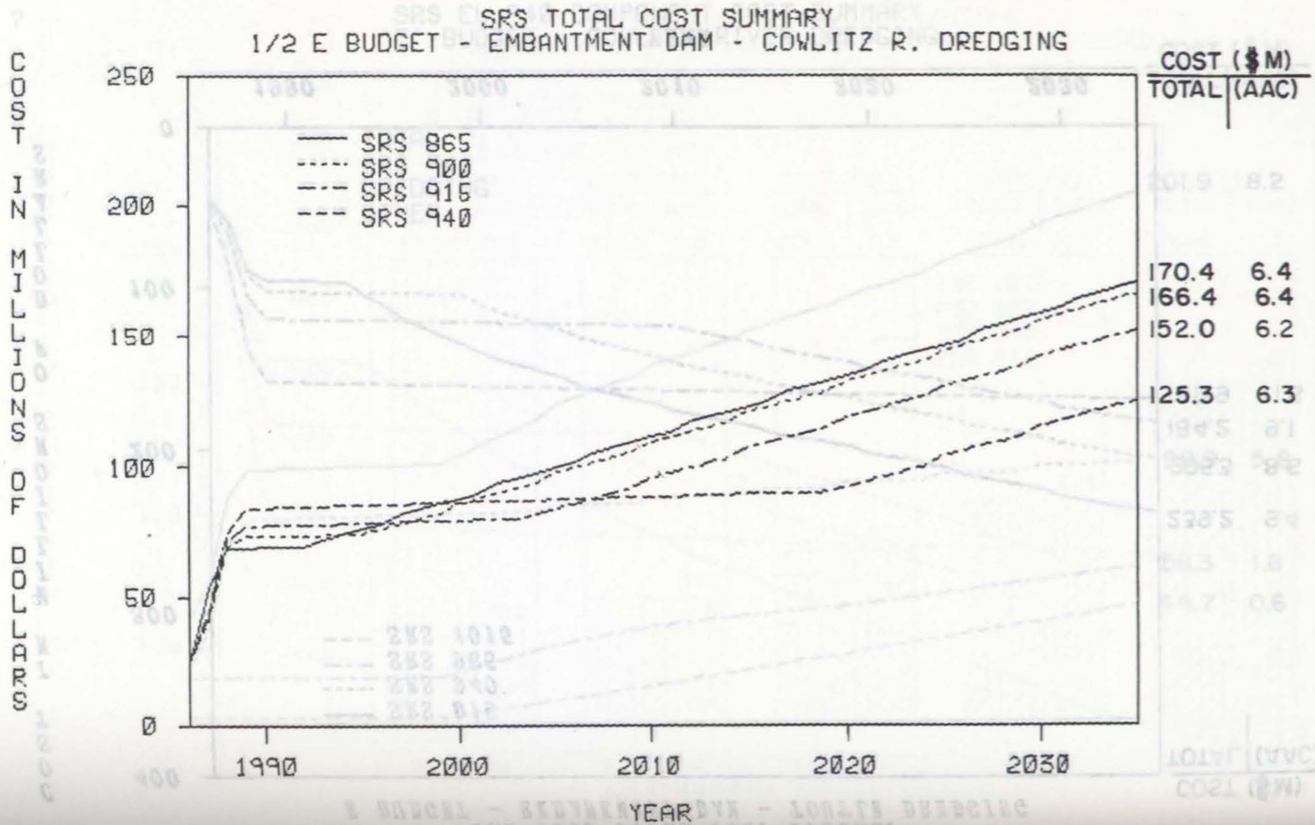


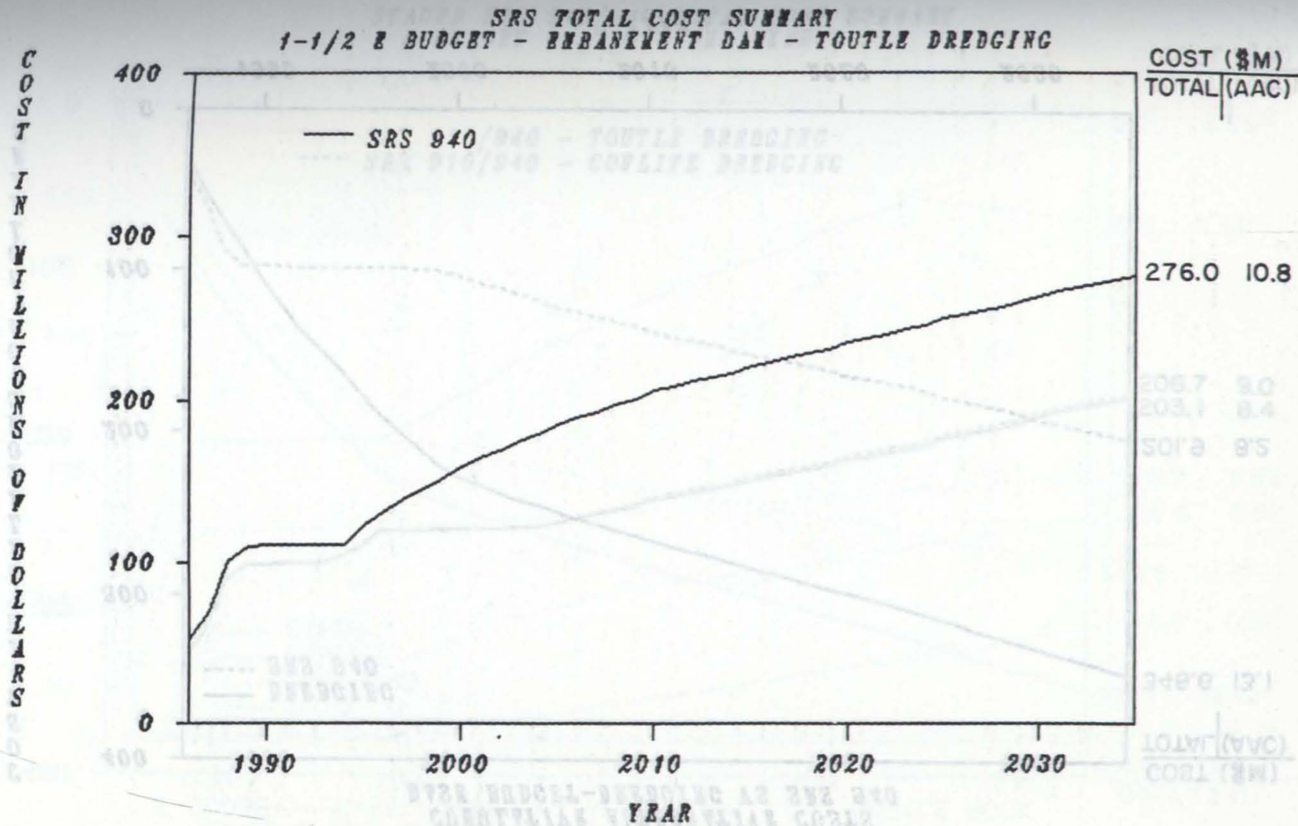


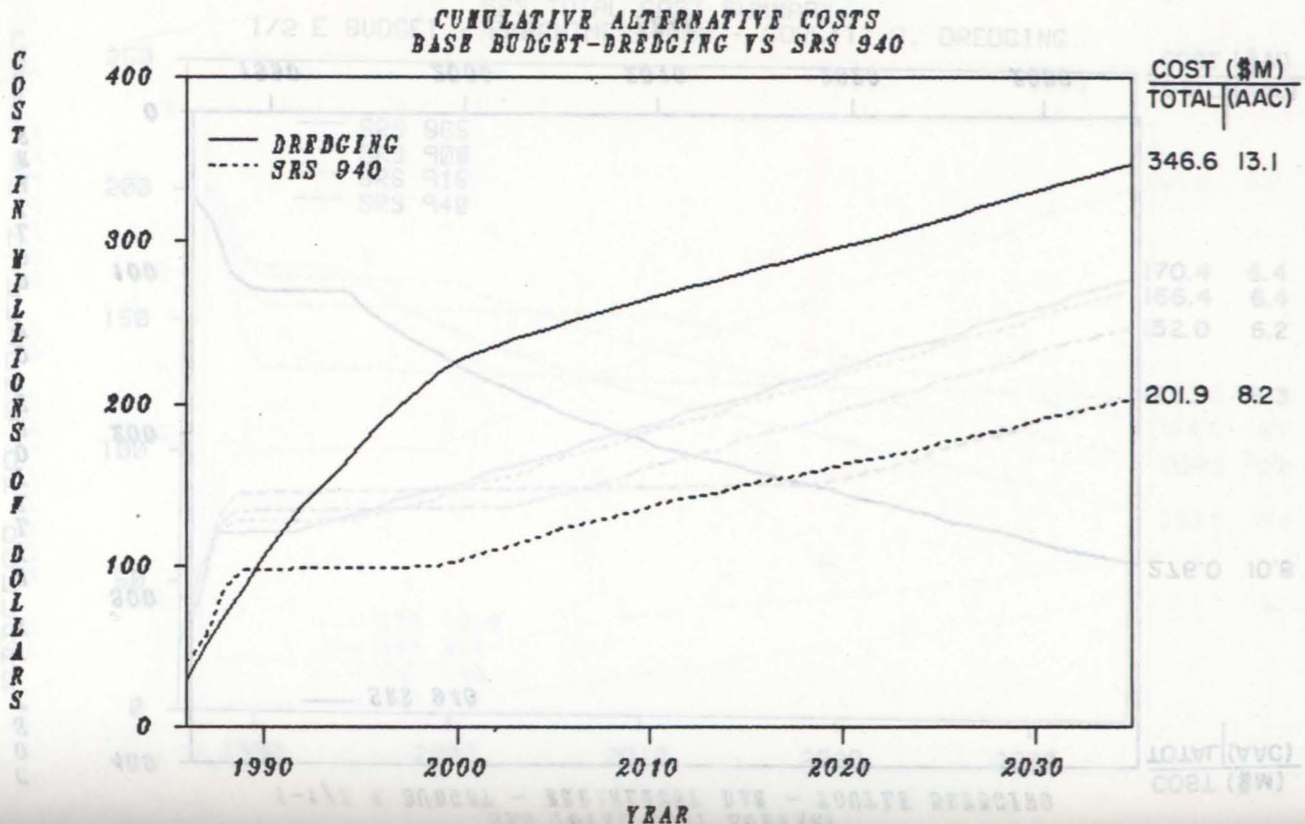
SRS EL 940 COMPONENT COST SUMMARY
'E' BUDGET - COWLITZ RIVER DREDGING
COST IN MILLIONS OF DOLLARS
250
200
150
100
50
0
1990
2000
2010
2020
2030
YEAR
TOTAL
SRS 940
DREDGING
OTHER
COST ($M)
TOTAL (AAC)
201.9 8.2
98.9 5.8
58.3 1.8
44.7 0.6

SRS COST TOTAL COST SUMMARY
E BUDGET - EMBANKMENT DAM - TOUTLE DREDGING

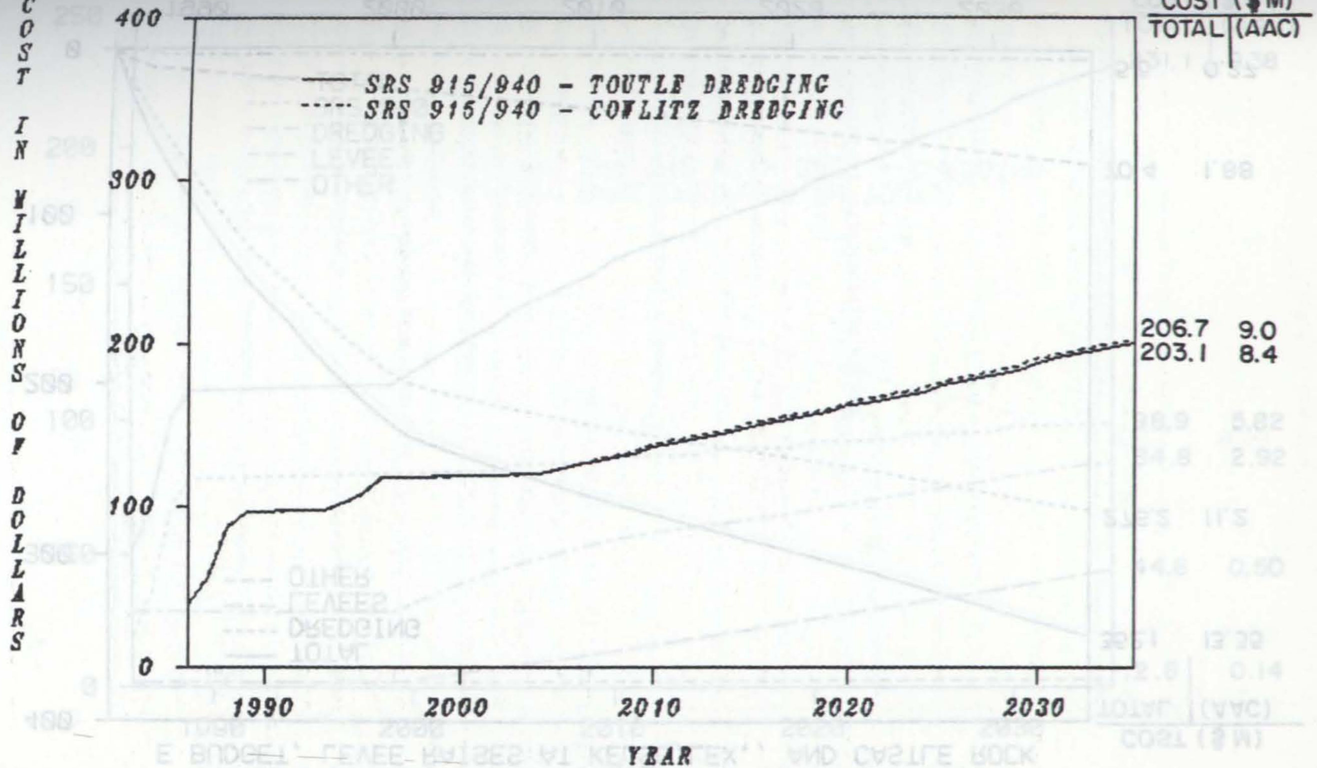


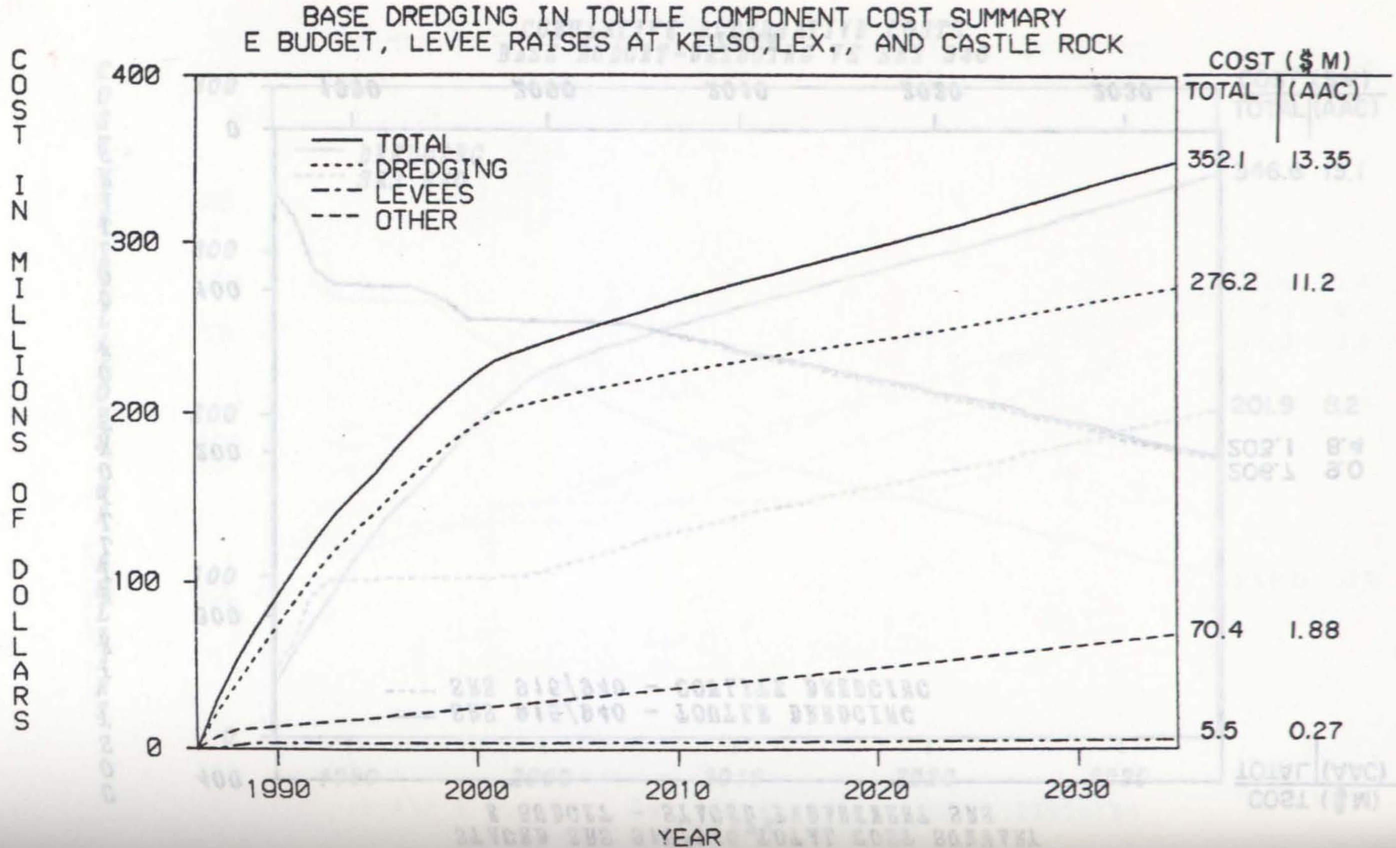

SRS TOTAL COST SUMMARY
1/2 E BUDGET - EMBANTMENT DAM - COWLITZ R. DREDGING
COST IN MILLIONS OF DOLLARS
250
200
150
100
50
0
SRS 865
SRS 900
SRS 915
SRS 940
1990
2000
2010
2020
2030
YEAR
COST ($M)
TOTAL
(AAC)
170.4 6.4
166.4 6.4
152.0 6.2
125.3 6.3


SRS TOTAL COST SUMMARY
1-1/2 % BUDGET - EMBANKMENT DAM - TOUTLE DREDGING
COST IN MILLIONS OF DOLLARS
400
300
200
100
0
SRS 940
COST ($M)
TOTAL (AAC)
276.0 10.8
1990
2000
2010
2020
2030
YEAR

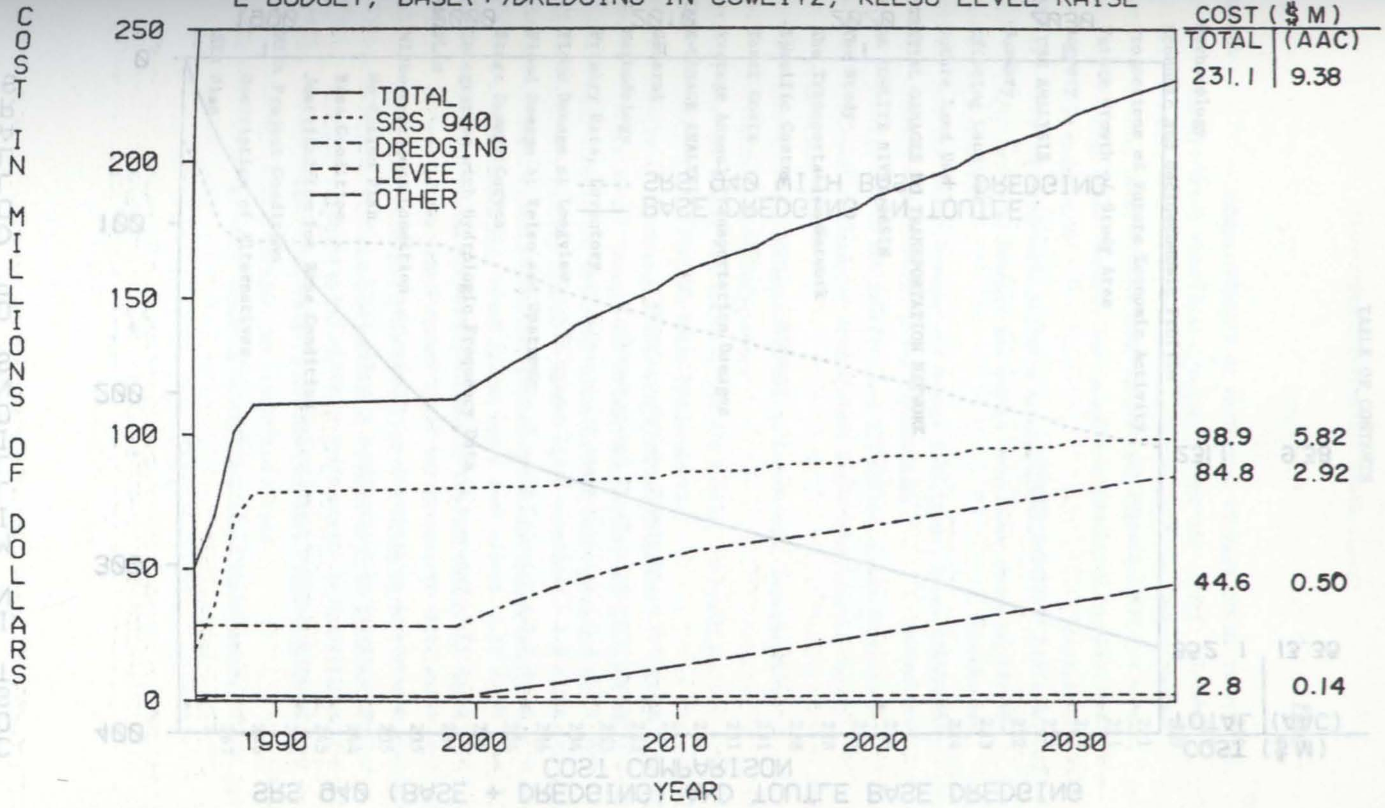

CUMULATIVE ALTERNATIVE COSTS
BASE BUDGET-DREDGING VS SRS 940
COSTS IN MILLIONS OF DOLLARS
400
300
200
100
0
1990
2000
2010
2020
2030
YEAR
DREDGING
SRS 940
COST ($M)
TOTAL (AAC)
346.6 13.1
201.9 8.2

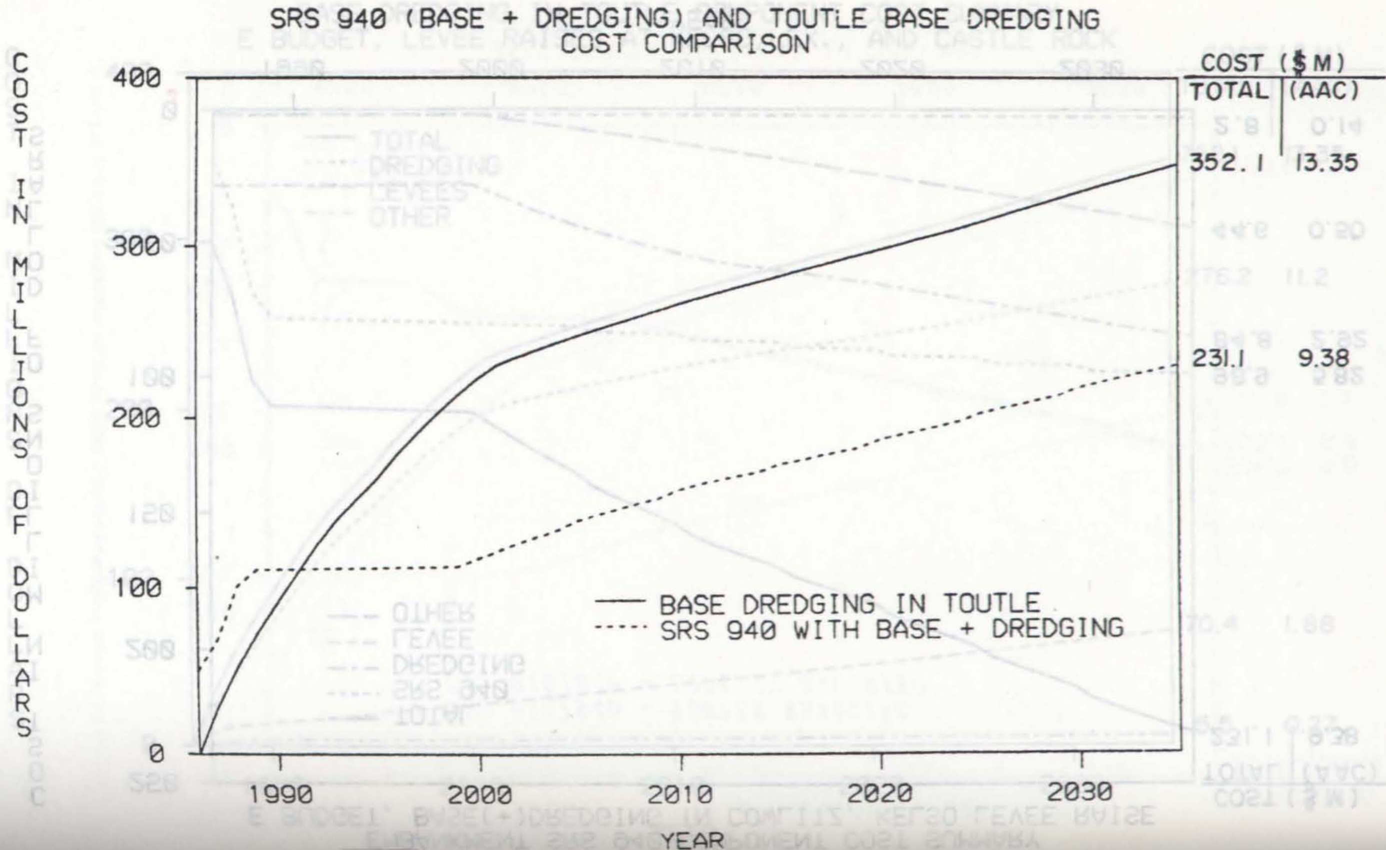
STAGED SRS 915/940 TOTAL COST SUMMARY
E BUDGET - STAGED EMBANKMENT SRS




BASE DREDGING IN TOUTLE COMPONENT COST SUMMARY
E BUDGET, LEVEE RAISES AT KELSO,LEX., AND CASTLE ROCK
COST IN MILLIONS OF DOLLARS
400
300
200
100
0
TOTAL
DREDGING
LEVEES
OTHER
1990
2000
2010
2020
2030
YEAR
COST ($ M)
TOTAL
(AAC)
352.1
13.35
276.2
11.2
70.4
1.88
5.5
0.27

EMBANKMENT SRS 940 COMPONENT COST SUMMARY
E BUDGET, BASE(+)DREDGING IN COWLITZ, KELSO LEVEE RAISE




SRS 940 (BASE + DREDGING) AND TOUTLE BASE DREDGING
COST COMPARISON
COST IN MILLIONS OF DOLLARS
400
300
200
100
0
1990
2000
2010
2020
2030
YEAR
BASE DREDGING IN TOUTLE
SRS 940 WITH BASE + DREDGING
COST ($M)
TOTAL
(AAC)
352.1
13.35
231.1
9.38

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APPENDIX C

ECONOMIC ANALYSES

GENERAL

An economic base study and analysis of Cowlitz County was conducted by Seattle District, Corps of Engineers in the latter part of 1982. Full results are available in a report dated January 1983. Data contained in the report was summarized in the Comprehensive Plan, Appendix D. A brief outline of the methodology and findings, adjusted for 1985 population and employment data, is described below.

Methodology

The survey was conducted by collecting economic and demographic data for the county, region, and state. These data were then used to construct a profile of the County's economy. After the basic data were compiled, an analysis of present and future conditions was made using an input-output model of Cowlitz County developed by W. Rompa and L. Miller, A Working Model for Estimating Economic Change in Cowlitz County, Washington (September, 1980). Transactions within the local economy take place between various sectors, including manufacturing, trade, households and government. Major economic sectors of Cowlitz County were identified and firms were classified as to type of activity. The sum of all transactions between the sectors reflects the county's gross economic activity.

Economic and Socioeconomic Profile

The 1984 Washington State estimate of Cowlitz County's population was 79,900, up slightly from the official 1980 census of 79,548. County population is projected to grow at the rate of .8 percent per year from 1980 to 2005. In 1984, 51 percent of the county's population was located in Kelso (10,840) and Longview (29,820). The other three urban, incorporated areas and their 1984 populations are Woodland (2,470), Castle Rock (2,125), and Kalama (1,170).

County-wide there were 31,748 housing units in 1980. The projected growth rate for households of 1.2 percent per year from 1980 to 2005 exceeds the county population growth rate of .8 percent per year over the same period. Accordingly, household size for the county will decline from 2.70 persons per household in 1980 to 2.42 in the year 2005, reflecting the increase in one-person households and a declining birth rate.

Per capita personal income for the county exceeded that for the state since the mid-1970's, due in part to the relatively high wages paid in the forest products industry. By 1982, however, county per capita income of $10,535 was below the state's $11,446, evidencing a slowdown in foreign and domestic forest products demand.

County employment increased by an average annual rate of 1.3 percent from 1950 to 1982, although growth rates by decade within this period have fluctuated considerably because of the behavior of the manufacturing sector, which accounts for 35 percent of Cowlitz County employment and 50 percent of total wages. In this sector lumber and wood products and paper and allied products account for about 28 percent of total employment. Other major employment sectors of the county are wholesale and retail trade, services, and government. Cowlitz County's 1980 labor force participation rate for all persons age 16 and older was 59.6 percent, 76.3 percent for males and 43.6 percent for females.

Unemployment rates in Cowlitz County steadily increased from 4.4 percent in 1974 to a high of 17.5 percent in 1982. Currently Cowlitz County unemployment rates have declined to 13.2 percent (April 1985). This figure is relatively high in comparison to the state-wide rate of 8.8 percent (April 1985). The high rate reflects a loss of jobs in the forest products industries, partly because of cyclical fluctuations in the national home building industry. However, timber supply, export competition, shifts in markets, and mechanization have contributed to a structural rather than a cyclical decline in the number of persons employed in the forest products industry.

An employment forecast by the Bonneville Power Administration projects employment to grow at 1.4 percent per year from 1980 to 2005. Overall

growth during this period in the manufacturing sector will be limited by lack of growth in the forest products industries. The sectors projected to show the largest growth are services, wholesale and retail trade, and government.

Projections of Future Economic Activity

Several industries have the potential to provide jobs in Cowlitz County. Of the manufacturing industries, chemical refining and its related activities offer some job opportunities, but because they utilize capital intensive strategies to achieve increased production, the number of positions is very limited.

Another sector that has potential to provide jobs is transportation, particularly the ports. Because their growth is closely tied to national and regional economic conditions, ports have expanded services despite local economic downturns. Directly and indirectly, the ports are able to generate a considerable number of new jobs relative to other sectors. Distribution of goods may induce expansion in the transportation sector, increasing the likelihood of some new jobs.

Of the non-manufacturing activities, retail trade appears to have the most promise. This sector has a wage scale that is low relative to the forest products industry, but it can provide employment in the near term. Related to the retail trade industry is the service sector, specifically, tourism. Tourism has the potential to provide a number of service-oriented jobs.

Future Growth of Study Area

In terms of opportunities in Cowlitz County for future economic development, forest products (e.g., primary and secondary wood manufacturing) and port activities (e.g., bulk handling facilities, assembly/distribution of imports, expansion of container facilities) appear to have the greatest potential for growth. Forest lands and timber processing are and will continue to be dominant parts of the economic foundation of the county. The dependence of the

forest products industries on the ports to ship their materials and to import chemicals required in manufacturing secondary wood products underscores the importance of port activities.

Fabricated metals, chemicals, apparel, and glass products all possess the potential to provide a large number of jobs, diversify the economy and stimulate economic growth. This is also the case for the three non-manufacturing sectors of retail trade, services, and finance, insurance, and real estate.

Summary

Given the predominance of forest products and related wood products manufacturing industries in the economic structure of Cowlitz County, and considering the structural changes these industries are undergoing, it is the general conclusion of this analysis that the study area will most likely experience only modest economic development and related growth of employment and population over the next several decades.

LAND USE ANALYSIS

Summary

The area analyzed was the Cowlitz River flood plain in Cowlitz County, Washington, from the mouth of the Cowlitz to RM 21.5. A land use inventory was performed by Seattle District, Corps of Engineers under contract with the Portland District, Corps of Engineers.

The study area was divided into five subareas and delineated by the following uses:

- o Residential, Single family (includes mobile homes on lots)
- o Residential, Multiple Family
- o Residential, Mobile Home (in mobile home parks only)
- o Commercial

- o Industrial
- o Transportation/Utilities (Major roads, railroads, repair shops; aircraft and water transport; radio and televison stations; water, sewer, electrical facilities)
- o Public/Recreation (Recreation areas, churches, museums, schools, etc.)
- o Agriculture
- o Dredged Disposal
- o Vacant

Existing Land Use

Subarea 1, Longview
There is substantial high density residential and commercial development within the city limits. There are also large areas of industrial activity along the Columbia River south and east of town, with substantial vacant property. There is abundant vacant, developable land in west Longview, some in agricultural use.

Subarea 2, Kelso
Single family residential is the largest land use, with a small amount of land in commercial use. There are approximately 100 acres of manufacturing-industrial use, mainly in an industrial park south of Kelso. The majority of transportation/utilities use is in the area of the Kelso Municipal Airport. Vacant land is well distributed, with unused lots in central, west and north Kelso, and larger tracts in east and south Kelso.

Subarea 3, Lexington
Single family residential makes up a vast majority of land use. Dredged material is the next largest, followed by agricultural use and vacant land. Some commercial use is located in the small central area.

Subarea 4, Castle Rock
Single family residential is the largest usage, with dredged material next largest land use, followed by agricultural and vacant land. Some commercial use exists in the small central area.

Subarea 5, Other Cowlitz River Floodplain

One half of this area contains dredged material; agricultural use and vacant land account for another 37 percent, with a minor amount in residential use.

Future Land Use

Analysis of the most probable use of land was made for the period 1985-2000. Near-term land use plans were considered (city, county, regional), along with zoning criteria, local attitudes, and conditions influencing development. Land use changes were based on population projections, economic and social factors, comprehensive plans, building and zoning regulations, and community needs. Factors complicating the analysis were uncertainty regarding flooding related to Mount St. Helens, land needed for future dredge disposal sites, the future of the forest products industry due to preservation of forest lands in the blast area for a national monument, and the status of the overall economy.

The greatest expected changes in use are to be in Subarea 1 Longview: 457 acres now vacant to be taken up by 152 acres of single-family residential and 305 acres for industrial use. Subarea 2, Kelso is expected to have 108 acres, now vacant or in dredged material, in commercial and industrial use by 2000. The only other foreseeable development is in Subarea 3, Lexington, with 87 acres of vacant and agricultural land, and dredged material, put into single family residential use. These changes are summarized in the tables following.

POTENTIAL DAMAGES TO THE TRANSPORTATION NETWORK IN THE COWLITZ RIVER BASIN

The Study

The study outlined herein was conducted for the Portland District, Corps of Engineers by Systan, Inc., of Los Altos, California, with construction cost estimates developed by Swan Wooster Engineering, Inc., Portland, Oregon. A summary of the transportation system analysis is contained in the Comprehensive Plan, Appendix D.

The study examined the transportation network in the area affected by flooding, washouts, mudflows, and volcanic-related activity and concentrated on the

Table C-1
Cowlitz River Flood Plain
Between Toutle River and Columbia River
Existing Land Use - by Subarea
1985

	Longview*		Kelso*		Lexington		Castle Rock		Other County		Total Flood Plain	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Residential	2,705	27	555	31	185	27	142	38	215	6	3,802	23
Single Family	(2,501)		(505)		(185)		(115)		(215)		(3,521)	
Multifamily	(204)		(50)		(0)		(27)		(0)		(281)	
Commercial	469	5	125	7	5	1	20	5	40	1	659	4
Industrial	1,958	19	95	5	0	0	5	1	15	1	2,073	12
Trans/Utilities	411	4	190	10	85	12	11	3	86	3	783	5
Public/Recreation	715	7	280	15	48	7	22	6	85	2	1,150	7
Vacant	2,524	25	490	27	192	28	40	11	690	19	3,936	24
Agricultural	1,318	13	0	0	50	7	50	14	644	18	2,062	12
Dredge Spoil	0	0	90	5	125	18	80	22	1,805	50	2,100	13
TOTAL	10,100	100	1,825	100	690	100	370	100	3,580	100	16,565	100

* Includes adjacent unincorporated flood plain areas.

Table C-2
Cowlitz River Flood Plain
Between Toutle River and Columbia River
Land Use Change - by Subarea
1985 - 2000

	Longview* (Acres)	Kelso* (Acres)	Lexington (Acres)	Castle Rock (Acres)	Other County (Acres)	Total Flood Plain (Acres)
Residential	+152	0	+87	0	0	+239
Single Family	(+152)	0	(+87)	(0)	(0)	(+239)
Multifamily	(0)	(0)	(0)	(0)	(0)	(0)
Commercial	0	+58	0	0	0	+58
Trans/Utilities	0	0	0	0	0	0
Industrial	+305	+50	0	0	0	+355
Public/Recreation	0	0	0	0	0	0
Vacant	-457	-50	-54	0	0	-561
Agriculture	0	0	-2	0	0	-2
Dredge Spoil	0	-58	-31	0	0	-89
TOTAL	0	0	0	0	0	0

* Includes adjacent unincorporated flood plain areas.

Table C-3
Cowlitz River Flood Plain
Between Toutle River and Columbia River
Future Land Use - by Subarea
2000

	Longview* Acres	%	Kelso* Acres	%	Lexington Acres	%	Castle Rock Acres	%	Other County Acres	%	Total Flood Plain Acres	%
Residential	2,857	28	555	31	272	39	142	38	215	6	4,041	24
Single Family	(2,653)		(505)		(272)		(115)		(215)		(3,760)	
Multifamily	(204)		(50)		(0)		(27)		(0)		(281)	
Commercial	469	5	183	10	5	1	20	5	40	1	717	4
Trans/Utilities	411	4	190	10	85	12	11	3	86	3	783	5
Industrial	2,263	22	145	8	0	0	5	1	15	1	2,428	15
Public/Recreation	715	7	280	15	48	7	22	6	85	2	1,150	7
Vacant	2,067	21	440	24	138	20	40	11	690	19	3,375	20
Agricultural	1,318	13	0	0	48	7	50	14	644	18	2,060	13
Dredge Spoil	0	0	32	2	94	14	80	22	1,805	50	2,011	12
TOTAL	10,100	100	1,825	100	690	100	370	100	3,580	100	16,565	100

* Includes adjacent unincorporated flood plain areas.

major north-south corridor which contains Interstate Highway 5 (I-5) and the Burlington-Northern Railroad line. Waterborne transportation was not included.

Economic impacts analyzed were the costs of reconstruction and damage repair, and costs of rerouting traffic during blockage and reconstruction. To examine the latter a number of scenarios were posited - various conditions that might reasonably occur - and the rerouting costs of each determined. The costs of repairing or reconstructing bridges and roads vary a great deal hence were arrived at separately.

The Transportation Network

The network's dominant features are Highway I-5 and the Burlington-Northern Railroad tracks. Highway I-5 is the major route for vehicular traffic between Portland, Oregon, and Seattle, Washington, as well as for considerable local traffic. The Burlington-Northern facilities serve that major railroad and Union Pacific Railway and AMTRAK passenger trains as well. Secondary roads (e.g., Route 411) and railroads (the Columbia Cowlitz) are of importance, but from a regional as well as local perspective, I-5 and the Burlington-Northern tracks have the greatest potential for economic disruption and cost. Both I-5 and the Burlington-Northern tracks are particularly vulnerable where their bridges cross the Toutle River near its confluence with the Cowlitz.

Specific Costs

Rerouting Vehicular Traffic

Seven highway rerouting scenarios were postulated by examining the detour routes that would be used when the transportation system is disrupted. The additional rerouting costs were identified for each detour scenario using the following approach:

1. Alternative detour routes were identified by examining existing regional contingency plans of the state and county, and the least costly detour in each case was used to estimate travel costs. It was generally

assumed that no economic activity would be interrupted, displaced, or transferred solely as a result of damage to the transportation network.

2. For each scenario the handling capacity of each stretch of road was determined by using standard highway design criteria and considering normal traffic levels on the alternate routes. When rerouted traffic exceeded capacity, the traffic was again rerouted to the next most feasible alternative route.

3. The additional miles and time needed to complete the detour were identified. This was done by adjusting travel speeds to reflect road gradient, horizontal curvature, and the queuing delay effects associated with stop-and-go traffic.

4. The vehicular operating costs were identified by vehicular type using the AASHTO manual[1] and were adjusted to reflect current price levels.

5. The additional travel time costs were computed by using the automobile driver and the adult passenger and truck driver values recommended in the AASHTO manual.[1] At current price levels, these two values were \$10 per vehicle hour for passenger cars and \$14 per vehicle hour for trucks.

The associated rerouting costs for each scenario are tabulated below:

Highway Reroute Scenarios	Thousands of \$ Per Day
I-5 bridges and all adjacent routes blocked: use of Routes 101 and 97 to detour around the Basin	2,700.7
Multiple blockage of I-5 and adjacent routes: use of Routes 101 and 97 to detour around the Basin	3,052.0
I-5 bridges blocked; use of Route 4/506	1,351.5
I-5 bridges blocked: use of old Highway 99	230.6
I-5 bridges blocked; use of 411/506 and old Highway 99	75.0
I-5 bridges blocked; short four-lane detour on old Highway 99	3.2
I-5 open; Route 411 blocked south of Castle Rock	0.7

1. A Manual on User Benefit Analysis on Highway and Bus Transit Improvements, American Association of Highway and Transportation Officials, Washington D.C., 1977.

Rerouting Rail Traffic

A prolonged break in, or blockage of, the Burlington-Northern tracks would require rerouting east along the Columbia River, north to Yakima, Washington, then west over Stampede Pass to Auburn and the Seattle area. The rerouting, taking Vancouver, Washington, as the starting place, would be 453 miles, as compared to the normal 155 miles between Vancouver to Auburn by the Cowlitz River route. AMTRAK would likely reroute its passengers by bus, unless I-5 were closed also. The freight rerouting costs were computed by examining standard Interstate Commerce Commission rates and estimating additional operating costs for the types of traffic to be rerouted. The costs varied between \$.35 and \$.42 per car mile. The additional cost of bus transportation, including passenger time, was used to compute detour costs for AMTRAK. Rerouting costs from closure of the Burlington-Northern tracks are summarized below.

Railroad Company	Additional Costs per Day I-5 Open	I-5 Closed
Burlington Northern	\$62,600	\$62,600
Union Pacific	4,300	4,300
AMTRAK passenger service	2,300	(32,500)
Total reroute costs	\$64,600	\$99,400

Repair, Reconstruction, and Replacement of Structures

If bridges across the Toutle and Cowlitz Rivers were destroyed or severely damaged, temporary structures would be required while major facilities are rebuilt. Costs and construction periods of temporary structures were developed from engineering data.

Costs of replacing the principal bridges of the network were also developed, along with construction periods. Other costs, such as removal of mud from roadways, were estimated and considered in the various sets of conditions studied.

Total Costs

If the three bridges across the Toutle River (I-5, Burlington-Northern Railroad, and old Highway 99) were destroyed, total losses could range from $98 million to $536 million. Four hypothetical cases were developed to exemplify how rerouting and replacement costs could be applied to estimate economic losses for a particular set of conditions. No prediction was made as to which case is more likely to occur.

Average Annual Transportation Damages

The transportation loss scenarios, utilizing cost data in the report, were incorporated into the flood damage analysis by determining at what flood stages the different scenarios would occur. The stage-damage relationship is shown on figure C-8. The stage-damage curve was combined with stage frequency data over time to derive average annual damages. Average annual transportation losses under the base condition are $132,000.

STAGE-DAMAGE ANALYSIS

General

Stage-damage analysis is a method of measuring potential damages to a flood plain area. This type of analysis measures flood-related damages for a series of hydrologic events which can be expected to occur in a given river basin or geographic area. It allows integration of damage costs with the probability, or frequency of occurrence of flood events. The result is an estimate of average annual flood damages which can be expected to occur in any given year. A comparison can then be made between damage/frequency under existing or no-action conditions and damage/frequency of proposed actions, to measure reduction in damages, or benefits, attributable to those actions. This method of analysis is used in this document to provide a measure of damages which would be incurred over a range of probable flood events on the Cowlitz and Toutle Rivers.

In this section the economic impact of various proposed solutions to the current flood threat in the Cowlitz and Toutle Rivers is analyzed. The base condition is compared to the no-action condition to demonstrate that continued maintenance of the base condition is justified. Damage reduction estimates are presented for various alternative measures, including dredging, levee improvement, single and multi-stage single retention structures (SRS's and MSRS's), and the most feasible combinations of these alternative measures. A National Economic Development (NED) solution to the flooding problem on the Cowlitz and Toutle Rivers is identified from among these alternatives, based on a comparison of average annual benefits and costs for protection provided by each alternative compared to the base condition.

The NED plan and the most cost effective dredging alternatives are then subjected to further analysis using sediment budgets 1/2 and 1-1/2 times the baseline sediment budget to determine how sensitive the NED plan is to greater or lesser volumes of sediment infill. Additionally, the sensitivity of sizing these alternatives for larger or smaller sediment loads is analyzed.

A risk analysis is included to test the effect of an additional low frequency flood, on the NED plan and the most cost effective dredging option.

Methodology

The stage-damage method requires the development of a flood plain inventory which includes identification of all improvements, or damage-susceptible property, in a given area or river reach (see LAND USE in this appendix). Each improvement is delineated by type, location, and ground floor elevation. The value of each improvement and its contents is determined from tax assessment records, valuation formulae, or individual appraisal.

Flood damage estimates were derived from two sources: Federal Insurance Administration tables, and damage assessment formulae previously developed by engineering consultants for the Corp's Willamette River Basin Flood Damage Study. This latter methodology estimates flood damages to residential, commercial, and industrial structures and contents, clean-up, utilities, etc. Application of these data results in estimates of damages to each type of improvement at given levels of inundation. In the case of specialized properties, structures, and contents were appraised individually by a real estate appraisal specialist.

Damages to improvements are then calculated for a series of water surface elevations. Damages at various flood levels are computed using depth-damage data developed by the Federal Insurance Administration, and using depth-damage relationships developed for Portland District by an engineering consulting firm. Damages have been updated to a fiscal year 1985 price level.

Primary Data, Inventory

Using the foregoing flood plain inventory methodology, an inventory of the City of Longview was performed by contract. Similar data for Kelso, Lexington, Castle Rock and unleveed areas, were compiled by Portland District. All

improvements were inventoried to determine type of improvement (e.g., residence, mobile home, commercial property, utilities), location, ground floor elevation, and value. Estimates of potential damages to major highways and railroads, bridges, and related transportation facilities were developed by a consultant under contract to Portland District.

Flood Damage at Longview

Flood damages were computed for improvements in Longview for various water surface elevations. Flooding was judged to begin with breaching of the existing levee along the Cowlitz River at its lowest elevations, with subsequent ponding occurring at the lowest ground elevation within that diking district. Damages were computed for 5-foot vertical intervals within Longview to reflect this ponding effect which would occur if the levee was breached.

Flood Damage at Kelso and Upstream

Stage-damage relationships were also developed for Kelso and all leveed and unleveed areas upstream of Longview-Kelso to the confluence of the Cowlitz and Toutle Rivers.

Stage-Damage Curves

Following computation of damages at different flood levels, stage-damage curves were constructed for 8 sub-reaches of the 4 major reaches along the lower 25 miles of the Cowlitz River (see Figures C-1 through C-8). These curves reflect the potential flood damages to improvements within each sub-reach related to water surface elevations. Results from the economic base and land use studies indicate that growth within the flood plain is relatively static and no significant future development is anticipated that would impact potential future damages. Therefore, it is assumed that stage-damage relationships will remain relatively constant over the project life.

Integration with Hydrologic Frequency Data

Data from the stage-damage curves were integrated with stage-frequency relationships for the Cowlitz River. This was done by averaging the damages at each flood level with damages from the preceding level and multiplying that amount by the interval between frequencies of each set of flood events. These frequencies have a probability of occurrence ranging from near annual (.95 probability) to 1-in-500 (.002 probability). The result is a dollar amount of damages which on average, will be incurred in any given year.

Under the no-action condition, the hydrologic characteristics of Cowlitz River will result in constantly changing stage- frequency relationships over time because of continued sediment buildup in the channel. Reduced channel capacity will cause continual changes in the river stages associated with flood events of a given frequency. For example, assuming no-action is taken in the interim, the stage of a 100-year frequency flood at river mile 5.5 in December 1985 is 29.4 feet (NGVD). The corresponding stage of a 100-year flood at river mile 5.5
in 1990 will be 32.0 feet, due to projected sediment infill. This situation is reflected in the stage-frequency relationships with change occurring on a year-to-year basis.

Probability of flood events was determined by watershed characteristics, post-eruption streamflow records, measured channel infill, and sediment deposition projected by a sediment transport model. The projected sediment budget assumes that future annual runoff and river flows will approximate normal water years, in which long-term average runoff conditions prevail.

NED PLAN

Without-Project Condition

No-Action Condition

Under the no-action scenario no additional flood reduction measures would be undertaken in the Cowlitz and Toutle Rivers subsequent to February, 1985. Annual flood damages will increase over time as sediment continues to infill

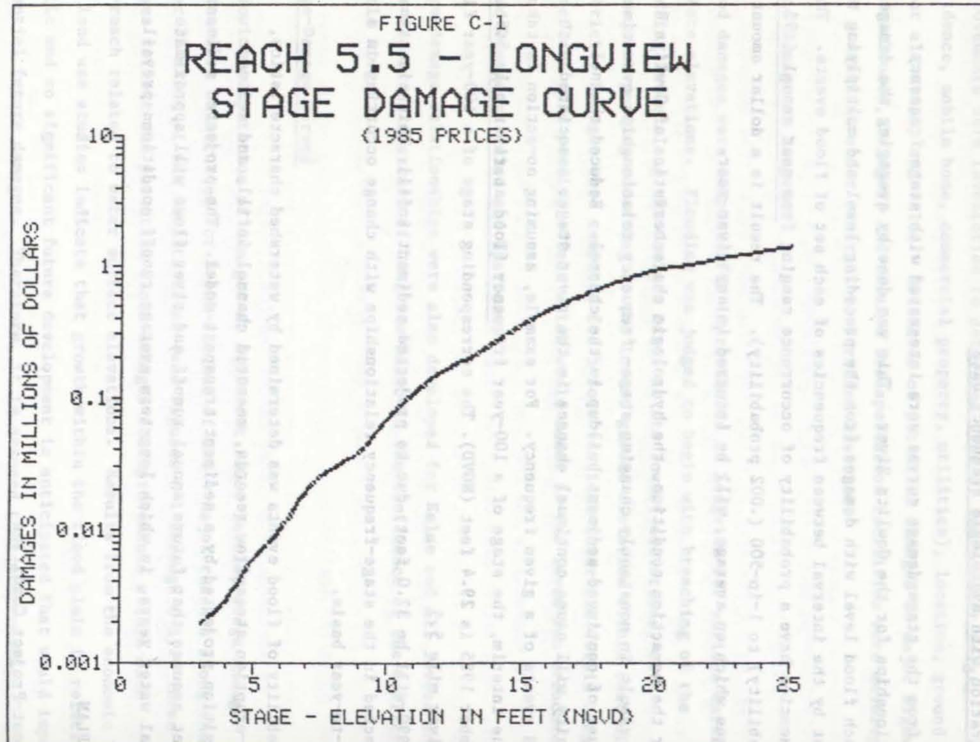


FIGURE C-1

REACH 5.5 - LONGVIEW
STAGE DAMAGE CURVE
(1985 PRICES)

FIGURE C-2

REACH 5.5 - KELSO
STAGE DAMAGE CURVE

(1985 PRICES)

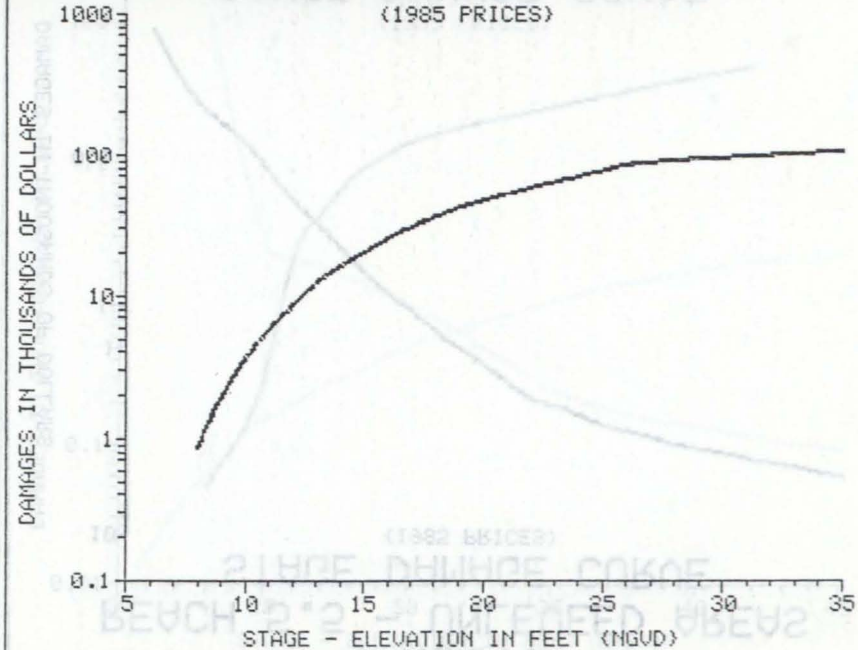
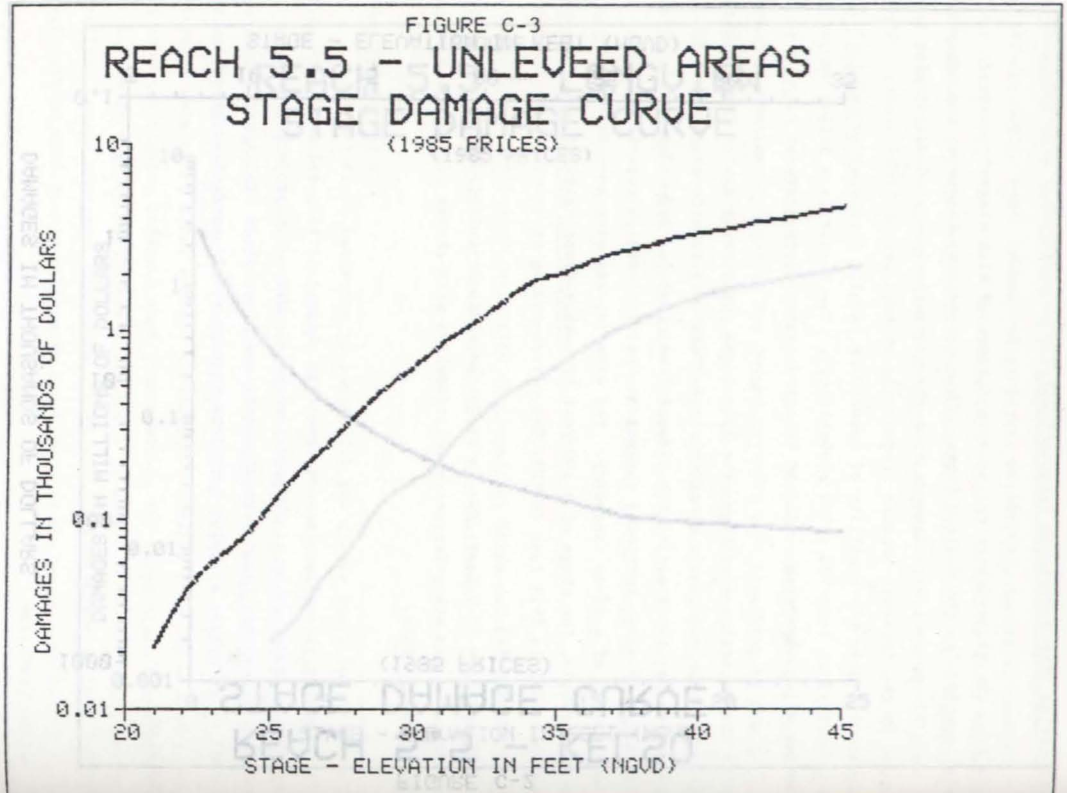


FIGURE C-3


REACH 5.5 - UNLEVEED AREAS
STAGE DAMAGE CURVE
(1985 PRICES)
DAMAGES IN THOUSANDS OF DOLLARS
10
1
0.1
0.01
20
25
30
35
40
45
STAGE - ELEVATION IN FEET (NGVD)

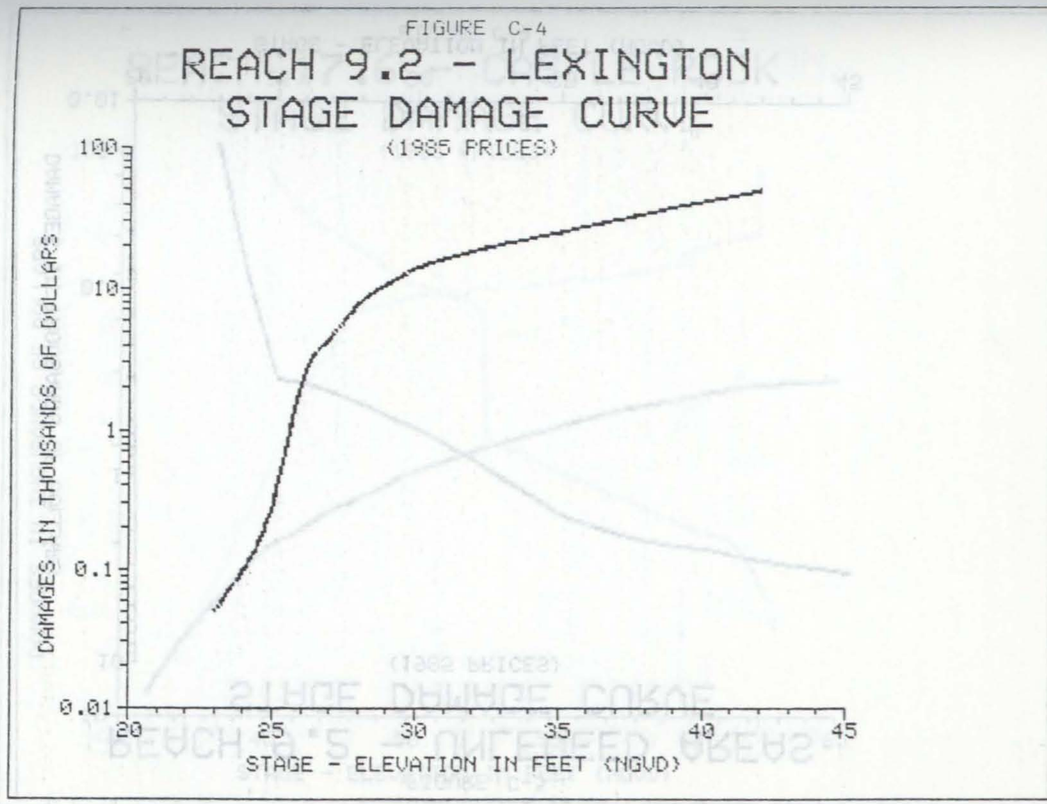


FIGURE C-4

REACH 9.2 - LEXINGTON
STAGE DAMAGE CURVE
(1985 PRICES)

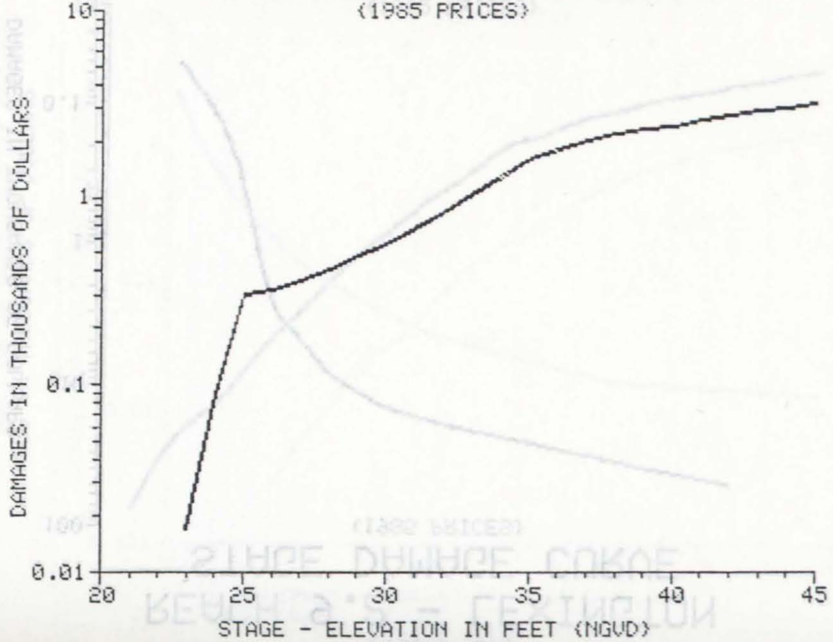


FIGURE C-5
REACH 9.2 - UNLEVEED AREAS
STAGE DAMAGE CURVE
(1985 PRICES)

FIGURE C-6

REACH 17.6 - CASTLE ROCK
STAGE DAMAGE CURVE
(1985 PRICES)

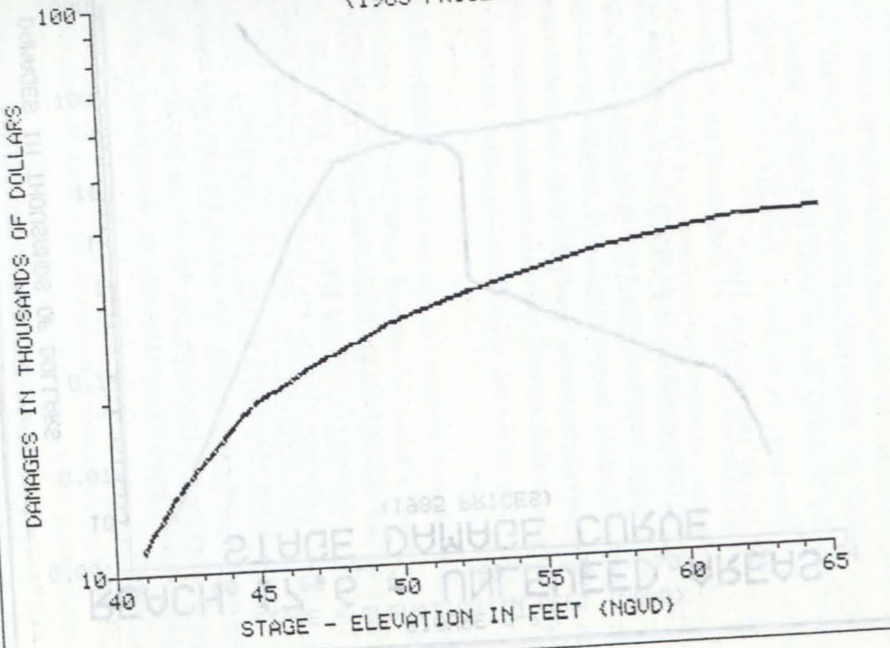


FIGURE C-7

REACH 17.6 - UNLEVEED AREAS
STAGE DAMAGE CURVE
(1985 PRICES)

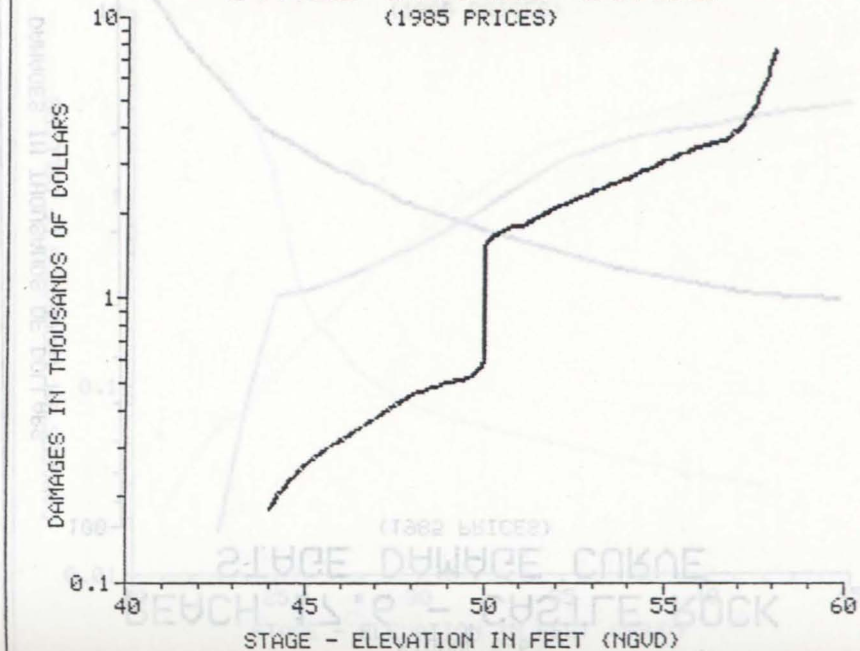
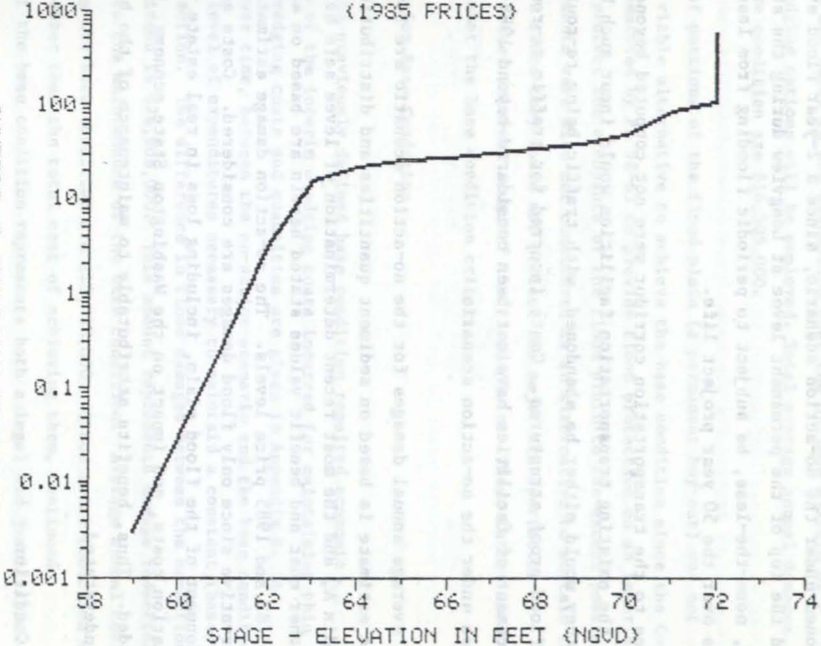


FIGURE C-8

REACH 19.6 - TRANSPORTATION STAGE DAMAGE CURVE

(1985 PRICES)



the river channel. Damage estimates were computed for each successive year until a 2 year event (.50 probability of occurrence) would overtop existing levees. Biennial inundation would dictate abandonment of existing improvements as damages incurred would be equal to or greater than their annualized value. Under these conditions, Kelso would be abandoned in the year 1996, Lexington in 1991, and Castle Rock in 1987. Longview would not be abandoned under the no-action scenario, since a 2-year flood event would not exceed the top of the permanent levee at Longview during the study period. It would, none-the-less, be subject to periodic flooding from less frequent events over the 50 year project life.

Damages to the transportation corridor were not computed beyond 1988. At this point the existing transportation facilities would incur such heavy damages that they would either be abandoned, with traffic being re-routed, or replaced with flood proof structures. Costs incurred for traffic re-routing or replacement of facilities have not been considered beyond 1988 in computing damages under the no-action scenario.

Total average annual damages for the no-action scenario are $43,411,000. This damage estimate is based on sediment quantities and distribution described in Appendix A, and the most recent determination of levee safe heights. This and all other cost and benefit values stated herein are based on an interest rate of 8-5/8% and 1985 price levels. The no-action damage estimate is conservative since only flood damages are considered. Costs associated with abandonment of the flood plain, including loss in real estate value, relocation costs, and impact on the Washington State economy, have not been included. Thus, benefits attributable to maintenance of the base condition are understated.

Base Condition

The base condition for this study is defined as the channel geometry existing in Cowlitz River as established by a hydraulic survey performed in November-December 1983. This channel geometry provides carrying capacity

which affords a level of protection that can be maintained over the long run by annual dredging of sediment infill. These measures were authorized by PL 98-63. The base condition described above represents the without project condition as defined by the Water Resource Council's Principles and Guidelines. It is the condition against which all project alternatives are compared. Cost and residual damage figures for the base condition presented in this document are based on the assumption that the optimum mixture of available dredging options will be employed. Total average annual damages under the base condition are $16,505,000.

Abandonment of portions of the flood plain (a permanent buy-out) was not considered a viable alternative to achieve the base condition since the Corps is legally committed by PL 98-63 to provide flood protection on an interim basis and to protect the occupants of the flood plain to the extent possible. Levee improvements were also not considered as an alternative to sustain the base condition since they would not protect the major transportation facilities or other unleveed areas of the flood plain. These latter measures alone do not meet the base condition criteria.

Justification for Base Condition

Adoption of the previously defined base condition required economic justification of the interim dredging costs incurred for maintaining this condition. Dredging costs and quantities are given in Appendix B. A comparison, over time, between the no-action scenario and the base condition reflects the level of expenditures necessary to maintain a constant (base) level of protection. The difference in flood damages between the no-action and base condition is $26,906,000. This amount represents damage reductions attributable to the maintenance of the base condition. Average annual costs of maintaining the base condition are $13,080,000. Since total reduction of damages is greater than the total cost of achieving them, continued maintenance of the base condition represents both a legal and justifiable activity. The benefit-to-cost ratio for maintenance of the base condition is 2.06-to-1.

The above costs and benefits differ from previous estimates for a variety of reasons. Modifications of the sediment budget and refinements in modeling of sediment movement and deposition patterns have had a major impact. A complete discussion of these changes can be found in Appendix A. Significant sediment infill is not expected to occur in the Columbia River under the present sediment budget and anticipated deposition patterns; therefore no additional costs are anticipated to maintain the Columbia River navigation channel. Levee safe heights at Longview and Kelso have also been refined from previous reports, based upon 1985 surveys of levee condition. Table C-4 summarizes average annual damages for the no-action and base conditions and average annual damage reductions resulting from maintenance of the base condition.

TABLE C-4
AVERAGE ANNUAL DAMAGES
AND DAMAGE REDUCTIONS
NO-ACTION AND BASE CONDITIONS
(000's)

Location	Damages No-Action Condition	Damages Base Condition	Total Damage Reductions
Longview	$ 3,537	$ 180	$ 3,357
Kelso	20,693	13,912	6,781
Lexington	2,645	273	2,372
Castle Rock	1,372	419	953
Unleveed Areas	854	1,589	(735)
Transportation	14,310	132	14,178
Total	$43,411	$16,505	$26,906

With-Project Condition

Description of Alternatives

General: In the Mt. St. Helens Comprehensive Plan (October 1983) five alternative strategies were identified as best suited to deal with the flood threat on the Cowlitz and Toutle Rivers posed by sediment flows from the

eruption of Mt. St. Helens. From this analysis, single retention structure (SRS) alternatives combined with downstream actions were identified for further study. In the Mt. St. Helens Feasibility Report (December 1984), the SRS's were analyzed in greater detail in terms of their costs, benefits, and capabilities, to determine optimum project size and location for this alternative.

As mentioned previously, formulation of the problem has changed somewhat for this decision document. Major refinements have been made to the sediment budget in which the quantity of sediment expected to move down the river system over time has been reduced by about 100 million cubic yards. In addition, the expected distribution of sediment has changed dramatically. For example, sediment infill in the Columbia River, a major source of potential costs in previous reports, is no longer expected to occur. Because of these changes, additional measures have been analyzed for this report in order to insure selection of the most cost effective alternative.

Three basic types of measures were analyzed; dredging, levee improvements, and construction of single and multi-stage SRS. Each of these measures provides flood protection in a different way. Dredging provides flood protection by removing sediment from the river channel and providing added capacity. The levee improvements provide flood protection by increasing the safe level of protection of the existing leveed areas where the majority of damages would occur. Retention structures function by slowing the flow of water in the river channel, this allows the sediment to filter out behind the structure, upstream of the damage susceptible areas.

These measures were combined in various ways to develop project alternatives. A measure is a single, specific action which may or may not solve a problem by itself; a project alternative is a measure or combination of measures, which will address the problem. The following alternatives were analyzed: dredging, levee improvements with a base level of dredging, levee improvements with an increased level of dredging, SRS's with supplemental dredging, and SRS's combined with levee improvements and supplemental dredging. A more detailed discussion of these alternatives follows, including a listing of average

annual damages, damage reductions, costs, net benefits, and benefit-to-cost ratios for each alternative. Finally, a summary review of the alternatives is included and selection of the NED plan, based on the principle of maximum net benefits, is discussed.

Dredging Alternatives: Three dredging alternatives were evaluated. The first was the base condition, which has been described previously. This is the minimum level of dredging which is required given the Corps legal commitment to provide a nominal level of protection. A maximum dredging alternative was analyzed which provides the greatest level of flood protection attainable by dredging measures alone. An intermediate level of dredging was also evaluated in order to identify the most cost effective dredging plan. The following table presents the level of protection provided by each dredging alternative for each leveed area.

TABLE C-5
LEVEL OF PROTECTION
DREDGING ALTERNATIVES
(recurrence interval in years)

	Toutle River	Cowlitz River
Base Condition	(1985-2000)	(2001-2035)
Longview	71	71
Kelso	3	3
Lexington	77	59
Castle Rock	71	20
Intermediate Dredging	(1985-1997)	(1998-2035)
Longview	167	149
Kelso	11	10
Lexington	167	143
Castle Rock	118	63
Maximum Dredging	(1985-1997)	(1998-2035)
Longview	303	270
Kelso	56	50
Lexington	313	263
Castle Rock	200	117

Water surface elevations vary, as do levels of protection, depending on whether dredging is accomplished in the Toutle River or in the Cowlitz River. Dredging in the Toutle River is generally less expensive than in the Cowlitz River due to the proximity of disposal areas. Therefore, dredging required by any alternative would initially be undertaken in the Toutle. When disposal areas adjacent to the Toutle are filled, dredging activity would shift to the Cowlitz River. It is estimated that disposal areas in the Toutle basin would be filled by the year 2000 for the base condition and 1997 for intermediate and maximum dredging options. Average annual damages and damage reductions for the dredging alternatives, measured against the base condition, are listed in Table C-6.

Net benefits for a particular dredging alternative are calculated by comparing the reduction in flood damages attributable to that plan, relative to the base, with the additional cost of providing that level of dredging over and above the cost of maintaining the base. Maintenance of the base condition through dredging is estimated to cost $13,080,000 annually. The intermediate level of dredging would have an average annual cost of $16,500,000, or $3,420,000 more than base level dredging. Average annual costs of a maximum dredging effort are $22,080,000, an increase of $9,000,000 over the base level.

Average annual damage reductions for the intermediate dredging option, compared to the base, are $11,332,000. Average annual net benefits for this alternative are $7,912,000. Damage reductions and net benefits for the maximum dredging option are $15,202,000 and $6,202,000 respectively, in average annual terms.

Levee Improvements: Three levee improvement alternatives were analyzed in conjunction with dredging to maintain base channel geometry. These three combinations are referred to as minimal, medium, and high levee improvements.

TABLE C-6
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
DREDGING ALTERNATIVES
(000's)

Intermediate Dredging

Location	Damages Base Condition	Damages Intermediate Dredging	Total Damage Reductions
Longview	$ 180	$ 28	$ 152
Kelso	13,912	3,895	10,017
Lexington	273	100	173
Castle Rock	419	195	224
Unleveed Areas	1,589	888	701
Transportation	132	67	65
Total	$16,505	$ 5,173	$11,332

Maximum Dredging

Location	Damages Base Condition	Damages Maximum Dredging	Total Damage Reductions
Longview	$ 180	$ 4	$ 176
Kelso	13,912	727	13,185
Lexington	273	31	242
Castle Rock	419	89	330
Unleveed Areas	1,589	417	1,172
Transportation	132	35	97
Total	$16,505	$ 1,303	$15,202

They were analyzed for the leveed areas of Longview, Kelso, Lexington, and Castle Rock. Levee improvements at each of the leveed areas are considered separate projects and were analyzed independently, as well as in combination. The base level of protection would be maintained in each case. This would provide some protection to unleveed areas and to transportation facilities since these areas would not benefit from levee improvements.

Minimal levee improvements amount to raising low spots and/or minor strengthening of the existing levees to bring them up to Corps standards. Minimal levee improvements would be in place in 1987. The existing levee at Longview meets Corps standards, therefore minimal levee improvements were not evaluated for this area. Construction of medium or high levees would require significant increases in the height and breath of existing levees. Medium and high levee raises would be in place in 1988; however, for these alternatives, protection equivalent to that of minimal levee improvements would be provided at Kelso in 1987 due to the significant benefit of providing protection there as soon as possible. Average annual damages and damage reductions for levee improvements measured against the base condition, are shown in Table C-7.

TABLE C-7
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
LEVEE IMPROVEMENTS
(000's)

Minimal Levee Improvements

Location	Damages Base Condition	Damages Minimal Levee	Total Damage Reductions
Longview	$ 180	$ 180	$ 0
Kelso	13,912	1,846	12,066
Lexington	273	165	108
Castle Rock	419	282	137
Unleveed Areas	1,589	1,589	0
Transportation	132	132	0
Total (Kl only)	$16,505	$ 4,439	$12,066
Total (Kl & Lx)	$16,505	$ 4,331	$12,174
Total (Kl & CR)	$16,505	$ 4,302	$12,203
Total (Kl Lx & CR)	$16,505	$ 4,194	$12,311

Medium Levee Improvements

Location	Damages Base Condition	Damages Medium Levee	Total Damage Reductions
Longview	$ 180	$ 114	$ 66
Kelso	13,912	1,441	12,471
Lexington	273	81	192
Castle Rock	419	133	286
Unleveed Areas	1,589	1,589	0
Transportation	132	132	0
Total (Kl Lx & CR)	$16,505	$ 3,490	$13,015

High Levee Improvements

Location	Damages Base Condition	Damages High Levee	Total Damage Reductions
Longview	$ 180	$ 28	$ 152
Kelso	13,912	1,223	12,689
Lexington	273	39	234
Castle Rock	419	40	379
Unleveed Areas	1,589	1,589	0
Transportation	132	132	0
Total (Kl Lx & CR)	$16,505	$ 3,051	$13,454

The average annual costs associated with each levee improvement option are shown in Table C-8.

TABLE C-8
AVERAGE ANNUAL COSTS
LEVEE IMPROVEMENTS
(000's)

Location	Minimal	Medium	High
Longview	N.A.	$ 2,270	$ 2,630
Kelso	$ 140	1,390	1,930
Lexington	100	350	520
Castle Rock	30	270	380

Table C-9 displays benefits, costs, net benefits and benefit-to-cost ratios for minimal levee improvements, and both medium and high levee raises at each location.

As independent measures, minimal levee improvement options are justified at Kelso, Lexington, and Castle Rock. Average annual net benefits for minimal levees are $11,926,000 for Kelso, $8,000 for Lexington, and $107,000 for Castle Rock. The construction of these three levees in combination yields maximum net benefits for the dredging option with levee raises. Since minimal levee improvements provide the maximum net benefits at Kelso, Lexington, and Castle Rock, construction of levees providing medium and high protection is not indicated at these locations.

For example, at Kelso, a medium levee raise provides net benefits of $11,081,000 and a high levee raise provides net benefits of $10,759,000. Both of these values are less than the $11,926,000 provided by minimal levee improvements, thus the additional benefits attributable to larger levees are more than offset by increased costs. No levee improvements are justified at Longview because the cost of these levees exceeds the benefits that would result from their construction.

TABLE C-9
AVERAGE ANNUAL NET BENEFITS AND B/C RATIOS
LEVEE IMPROVEMENTS
(dollars in thousands)

Alternative	Benefits	Costs	Net Benefits	B/C Ratios
Minimal Levee Improvements				
at Longview	N.A.	N.A.	N.A.	N.A.
at Kelso	$12,066	$140	$11,926	86.19 to 1
at Lexington	$108	$100	$8	1.08 to 1
at Castle Rock	$137	$30	$107	4.57 to 1
Combinations of Minimal Levees				
at Kl & Lx	$12,174	$240	$11,934	50.73 to 1
at Kl & CR	$12,203	$170	$12,033	71.78 to 1
at Kl Lx & CR	$12,311	$270	$12,041	45.60 to 1
Medium Levee Raises				
at Longview	$66	$2,270	($2,204)	0.03 to 1
at Kelso	$12,471	$1,390	$11,081	8.97 to 1
at Lexington	$192	$350	($158)	0.55 to 1
at Castle Rock	$286	$270	$16	1.06 to 1
High Levee Raises				
at Longview	$152	$2,630	($2,478)	0.06 to 1
at Kelso	$12,689	$1,930	$10,759	6.57 to 1
at Lexington	$234	$520	($286)	0.45 to 1
at Castle Rock	$379	$380	($1)	1.00 to 1

Intermediate Dredging with Minimal Levee Improvements: Four minimal levee combinations were evaluated in conjunction with intermediate levels of dredging. These included: (1) intermediate dredging with minimal levee improvements at Kelso only, (2) at Kelso and Lexington, (3) at Kelso and Castle Rock, and (4) at Kelso, Lexington and Castle Rock. The components of these alternatives have been discussed previously in this report. Minimal levee improvements at Kelso were reviewed in each alternative because they were justified individually by a wide margin. Table C-10 lists levels of protection at the leveed areas for the intermediate dredging option with minimal levee improvements.

TABLE C-10
INTERMEDIATE DREDGING WITH MINIMAL LEVEE IMPROVEMENTS
LEVELS OF PROTECTION
(recurrence interval in years)

Location	Toutle Dredging	Cowlitz Dredging
Longview 1/	167	149
Kelso	143	139
Lexington	233	192
Castle Rock	133	71

1/ Protection at Longview is the result of intermediate dredging only; no minimal levee is included for this location.

Table C-11 lists average annual damages for the base condition and dredging/levee alternatives, and average annual damage reductions attributable to each.

TABLE C-11
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
INTERMEDIATE DREDGING WITH MINIMAL LEVEES
(000's)

Location	Damages Base Condition	Damages for Dredging Plus Levees	Total Damage Reductions
Longview	$ 180	$ 28	$ 152
Kelso	13,912	565	13,347
Lexington	273	59	214
Castle Rock	419	183	236
Unleveed Areas	1,589	888	701
Transportation	132	67	65
Total (Kl only)	$16,505	$ 1,843	$14,662
Total (Kl & Lx)	$16,505	$ 1,802	$14,703
Total (Kl & CR)	$16,505	$ 1,831	$14,674
Total (Kl Lx & CR)	$16,505	$ 1,790	$14,715

Table C-12 displays benefits, costs, net benefits, and benefit-to-cost ratios for the intermediate dredging with minimal levee improvement alternatives.

TABLE C-12
AVERAGE ANNUAL NET BENEFITS AND B/C RATIOS
INTERMEDIATE DREDGING WITH MINIMAL LEVEES
(dollars in thousands)

Alternative	Benefits	Costs	Net Benefits	B/C Ratios
Kelso only	$14,662	$3,560	$11,102	4.12 to 1
Kl & Lx	14,703	3,660	11,043	4.02 to 1
Kl & CR	14,674	3,590	11,084	4.09 to 1
Kl Lx & CR	14,715	3,690	11,025	3.99 to 1

The project that provides intermediate dredging and minimal levee improvements at Kelso only is the optimum project evaluated from this group. It provides net benefits of $11,102,000.

Single Retention Structures: A single retention structure (SRS) functions by slowing the flow of water in the river channel and allowing sediment to filter out. Sediment not trapped behind the SRS must be removed from the channel at a downstream site. Each SRS option, in combination with some level of supplemental dredging, was designed to provide approximately the same level of protection as base dredging. In fact, the SRS options provide somewhat greater protection. An SRS may be constructed as a single unit, or as a multi-stage project. It would be situated on the upper Toutle River near its confluence with Green River. This site was selected in previous studies.

For the single stage SRS, five spillway heights, in combination with supplemental dredging, were evaluated. These spillway heights are 50, 100, 125, 150, and 200 feet. Four multi-staged SRS alternatives, in combination with supplemental dredging, were also evaluated. These are as follows:

(I) A 100 foot MSRS designed to function as the base for a 125 foot structure.

(II) A 100 foot MSRS designed to function as the base for a 125 foot structure, with an additional 12.5 foot structure to be added when required. Total height of this structure is 112.5 feet.

(III) A 100 foot MSRS designed to function as the base for a 125 foot structure, with two additional 12.5 foot structures to be added when required. Total height of this structure is 125 feet.

(IV) A 100 foot MSRS designed to function as the base for a 125 foot structure, with an additional 25 foot structure to be added when required. Total height of this structure is 125 feet.

All single stage SRS options are planned to be operational in 1987, as are the first stages of the multi-stage alternatives. Timing for construction of additional stages would depend on the rate of sedimentation experienced.

Since the amount of sediment retained varies depending on the height of the SRS, material that is not retained by the structure must be removed from the river channel at a location downstream from the SRS. With small structures, larger amounts of material must be removed downstream, conversely, with large structures, less material will require dredging. Costs will vary with structure size and amount of dredging required. Supplemental dredging would be accomplished primarily in the Cowlitz River. All nine single and multi-stage SRS alternatives, in combination with varying levels of supplemental dredging, provide the same level of flood protection and prevent the same amount of average annual damages. Table C-13 lists levels of protection provided at each location by the SRS alternatives.

TABLE C-13
LEVELS OF PROTECTION PROVIDED BY SRS ALTERNATIVES
(recurrence interval in years)

Location	SRS Level of Protection
Longview	100
Kelso	4
Lexington	91
Castle Rock	71

Table C-14 presents average annual damages and damage reductions for the SRS alternatives relative to the base condition.

TABLE C-14
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
SRS ALTERNATIVES
(000's)

Location	Base Damages	Damages with SRS	Damage Reductions
Longview	$ 180	$ 124	$ 56
Kelso	13,912	10,222	3,690
Lexington	273	227	46
Castle Rock	419	234	185
Unleveed Areas	1,589	1,488	101
Transportation	132	97	35
Total	$16,505	$12,392	$ 4,113

In addition to average annual damage reductions of $4,113,000 for flood control, an SRS, when in place, eliminates dredging which would otherwise be necessary to maintain the base condition. This amounts to a $13,080,000 annual cost savings. Therefore, total average annual benefits for each SRS alternative are $17,193,000. Table C-15 presents benefits, costs, net benefits and benefit-to-cost ratios for the SRS alternatives.

TABLE C-15
SINGLE RETENTION STRUCTURE ALTERNATIVES
AVERAGE ANNUAL NET BEBEFITS AND B/C RATIOS
(dollars in thousands)

Alternative	Damage Reductions	Dredging Savings	Benefits	Costs	Net Benefits	B/C Ratios
Single Stage						
50 ft.	$ 4,113	$13,080	$17,193	$11,790	$ 5,403	1.46 to 1
100 ft.	4,113	13,080	17,193	8,760	8,433	1.96 to 1
125 ft	4,113	13,080	17,193	8,150	9,043	2.11 to 1
150 ft.	4,113	13,080	17,193	8,700	8,493	1.98 to 1
200 ft.	4,113	13,080	17,193	11,250	5,943	1.53 to 1

TABLE C-15 (continued)

Alternative	Damage Reductions	Dredging Savings	Benefits	Costs	Net Benefits	B/C Ratios
Multi-Stage						
I	$ 4,113	$13,080	$17,193	$ 9,160	$ 8,033	1.88 to 1
II	4,113	13,080	17,193	8,980	8,213	1.91 to 1
III	4,113	13,080	17,193	8,610	8,583	2.00 to 1
IV	4,113	13,080	17,193	8,450	8,743	2.03 to 1

The optimal single stage SRS is the 125 foot high structure. This structure has average annual net benefits of $9,043,000. The optimal multi-stage SRS is alternative four which is 100 feet high initially, with a second 25 foot increment to be added in 1997. This alternative has net benefits of $8,743,000. Based on this evaluation, the single stage SRS provides greater net benefits than an equivalent SRS constructed in increments.

SRS with Minimal Levee Improvements: A group of alternatives were analyzed which combine an SRS with minimal levee improvements. Four alternatives were evaluated: the first evaluates an SRS with minimal levee improvements at Kelso only, the second includes minimal levee improvements at Kelso and Lexington, the third includes minimal levee improvements at Kelso and Castle Rock, and the fourth, minimal levee improvements at Kelso, Lexington, and Castle Rock. The 125 foot single stage SRS, identified in the preceeding section, was used for this evaluation. The minimal levee improvements at Kelso were included in each alternative because these improvements are justified by a wide margin when analyzed separately.

These alternatives increase the level of protection at each of the leveed areas when compared to levels of protection offered by the SRS alone. The level of protection at Kelso increases from 4 year protection to 77 year protection, Lexington increases from 91 year to 133 year protection, and Castle Rock increases from 71 year to 91 year protection. The level of

protection for Longview and the unleveed areas remains the same as that provided by the SRS only. Table C-16 lists average annual damages and damage reductions relative to the base for each of these alternatives.

TABLE C-16
SRS WITH MINIMAL LEVEE IMPROVEMENTS
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
($000's)

Alternative	Base Damages	Damages SRS + Levees	Damage Reductions
Longview	$ 180	$ 124	$ 56
Kelso	13,912	1,699	12,213
Lexington	273	151	122
Castle Rock	419	192	227
Unleveed Areas	1,589	1,488	101
Transportation	132	97	35
Kelso Only	$16,505	$ 3,869	$12,636
Kl & Lx	$16,505	3,793	12,712
Kl & CR	$16,505	3,827	12,678
Kl Lx & CR	$16,505	3,751	12,754

In addition to the average annual damage reductions presented in the previous table, these alternatives also eliminate the need to dredge to maintain the base condition. This is a cost saving of $13,080,000 annually.

The average annual cost for each alternative can be calculated by summing the average annual cost of the 125 foot single stage SRS ($8,150,000) with the average annual cost of the applicable minimal levee improvements ($140,000 at Kelso, $100,000 at Lexington, and $30,000 at Castle Rock). Thus the cost of

the first alternative (SRS + Kelso only) is $8,290,000, the cost of the second alternative (SRS + Kelso + Lexington) is $8,390,000, the cost of the third alternative (SRS + Kelso + Castle Rock) is $8,320,000, and the cost of the fourth alternative (SRS + Kelso + Lexington + Castle Rock) is $8,420,000. Benefits, costs, net benefits and B/C ratios for these four alternatives are provided in Table C-17.

TABLE C-17
SRS WITH MINIMAL LEVEE IMPROVEMENTS
AVERAGE ANNUAL NET BENEFITS AND B/C RATIOS
(dollars in thousands)

Alternative	Damage Reductions	Cost Savings	Benefits	Costs	Net Benefits	B/C Ratios
Kelso only	$12,636	$13,080	$25,716	$8,290	$17,426	3.10 to 1
Kl & Lx	$12,712	$13,080	$25,792	$8,390	$17,402	3.07 to 1
Kl & CR	$12,678	$13,080	$25,758	$8,320	$17,438	3.10 to 1
Kl Lx & CR	$12,754	$13,080	$25,834	$8,420	$17,414	3.07 to 1

The alternative with the greatest net benefits from this group is that which provides for an SRS with minimal levee improvements at Kelso and Castle Rock. This alternative has benefits of $25,758,000, costs of $8,320,000, and net benefits of $17,438,000.

SRS with Base-Plus Dredging: An alternative was analyzed that combines an SRS with dredging protection that exceeds base. This level of protection will be referred to as "base-plus" in this document. Unlike the SRS alternatives evaluated previously in this report, this alternative was designed to provide levels of protection similar to the intermediate dredging plan rather than base level dredging. The 125 foot SRS, identified in the preceeding section, was used for this evaluation. Table C-18 displays levels of protection for the SRS with base-plus dredging alternative.

TABLE C-18
LEVELS OF PROTECTION
SRS WITH BASE-PLUS DREDGING
(recurrence interval in years)

Base-Plus Dredging	Toutle River
Longview	167
Kelso	11
Lexington	167
Castle Rock	118

Table C-19 lists average annual damages and damage reductions for the SRS with base-plus dredging.

TABLE C-19
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
SRS WITH BASE-PLUS DREDGING ALTERNATIVE
(000's)

Location	Damages Base Condition	Damages SRS and Base-Plus Dredging	Total Damage Reductions
Longview	$ 180	$ 28	$ 152
Kelso	13,912	3,895	10,017
Lexington	273	100	173
Castle Rock	419	195	224
Unleveed Areas	1,589	888	701
Transportation	132	67	65
Total	$16,505	$ 5,173	$11,332

In addition to the average annual damage reductions presented in the preceeding table, this alternative also eliminates the need to dredge to maintain the base condition. This is a cost saving of $13,080,000 annually, for a total benefit of $24,412,000. The average annual cost for the SRS with base-plus dredging alternative is $9,240,000. Thus net benefits for this alternative are $15,172,000 and the benefit-to-cost ratio is 2.64 to 1.

SRS with Base-Plus Dredging and Minimal Levee Improvements: Four minimal levee improvement options were evaluated with the SRS and base-plus dredging alternative: the first includes minimal levee improvements at Kelso only, the second considers minimal levee improvements at Kelso and Lexington, the third includes minimal levee improvements at Kelso and Castle Rock, and the fourth, minimal levee improvements at Kelso, Lexington, and Castle Rock. The minimal levee improvements at Kelso were included in each alternative because these improvements are justified by a wide margin when analyzed separately.

These alternatives increase the level of protection at each of the leveed areas when compared to the SRS with base-plus dredging alone. The level of protection at Longview stays at 167 year protection, Kelso increases from 11 year protection to 143 year protection, Lexington increases from 167 year to 233 year protection, and Castle Rock increases from 118 year to 133 year protection. Table C-20 gives average annual damages and damage reductions relative to the base for each of these alternatives.

Table C-20
SRS WITH BASE-PLUS DREDGING AND
MINIMAL LEVEE IMPROVEMENTS
AVERAGE ANNUAL DAMAGES AND DAMAGE REDUCTIONS
(000's)

Location	Damages Base Condition	Damages for SRS, Dredging and Levees	Total Damage Reductions
Longview	$ 180	$ 28	$ 152
Kelso	13,912	565	13,347
Lexington	273	59	214
Castle Rock	419	183	236
Unleveed Areas	1,589	888	701
Transportation	132	67	65
Total (Kl only)	$16,505	$ 1,843	$14,662
Total (Kl & Lx)	$16,505	$ 1,802	$14,703
Total (Kl & CR)	$16,505	$ 1,831	$14,674
Total (Kl Lx & CR)	$16,505	$ 1,790	$14,715

In addition to the average annual damage reductions presented in the previous table, these alternatives also eliminate the need to dredge to maintain the base condition. This is a cost saving of $13,080,000 annually.

The average annual cost for each alternative is the sum of the average annual cost of the SRS with base-plus dredging ($9,240,000) and the average annual cost of the applicable minimal levee improvements ($140,000 at Kelso, $100,000 at Lexington, and $30,000 at Castle Rock). Thus the cost of the first alternative (Kelso only) is $9,380,000, the cost of the second alternative (Kelso + Lexington) is $9,480,000, the cost of the third alternative (Kelso + Castle Rock) is $9,410,000, and the cost of the fourth alternative (Kelso + Lexington + Castle Rock) is $9,510,000. Benefits, costs, net benefits and B/C ratios for these four alternatives are provided in Table C-21.

TABLE C-21
SRS WITH BASE-PLUS DREDGING AND
MINIMAL LEVEE IMPROVEMENTS
Average Annual Net Benefits and B/C Ratios
(dollars in thousands)

Alternative	Damage Reductions	Cost Savings	Benefits	Costs	Net Benefits	B/C Ratios
Kelso only	$14,662	$13,080	$27,742	$ 9,380	$18,362	2.96 to 1
Kl & Lx	$14,703	$13,080	$27,783	$ 9,480	$18,303	2.93 to 1
Kl & CR	$14,674	$13,080	$27,754	$ 9,410	$18,344	2.95 to 1
Kl Lx & CR	$14,715	$13,080	$27,795	$ 9,510	$18,285	2.92 to 1

The alternative with the greatest net benefits is that which provides for an SRS with base-plus dredging and minimal levee improvements at Kelso only. This alternative yields $18,362,000 in net benefits and is the optimal project from this group.

NED Plan

Identification of the NED plan is based on the principle of maximum net benefits as required by Corps of Engineers guidance. Net benefits are defined as the difference between total benefits and total costs. Benefits, costs, net benefits and benefit-to-cost ratios for each of the project alternatives are presented in Table C-22.

TABLE C-22
COWLITZ - TOUTLE PROJECT ALTERNATIVES
AVERAGE ANNUAL NET BENEFITS AND B/C RATIOS
(dollars in thousands)

Alternative	Benefits	Costs	Net Benefits	B/C Ratios
Intermediate Dredging				
	$11,332	$3,420	$7,912	3.31 to 1
Maximum Dredging				
	$15,202	$9,000	$6,202	1.69 to 1
Minimal Levee Improvements				
at Kelso	$12,066	$140	$11,926	86.19 to 1
at Lexington	$108	$100	$8	1.08 to 1
at Castle Rock	$137	$30	$107	4.57 to 1
Combinations of Minimal Levees				
at Kl & Lx	$12,174	$240	$11,934	51.73 to 1
at Kl & CR	$12,203	$170	$12,033	71.78 to 1
at Kl Lx & CR	$12,311	$270	$12,041	45.60 to 1
Medium Levee Raises				
at Longview	$66	$2,270	($2,204)	0.03 to 1
at Kelso	$11,631	$1,250	$10,381	9.30 to 1
at Lexington	$192	$350	($158)	0.55 to 1
at Castle Rock	$286	$270	$16	1.06 to 1
High Levee Raises				
at Longview	$152	$2,630	($2,478)	0.06 to 1
at Kelso	$11,848	$1,790	$10,058	6.62 to 1
at Lexington	$234	$520	($286)	0.45 to 1
at Castle Rock	$379	$380	($1)	1.00 to 1
Intermediate Dredging + Minimal Levee				
at Kelso only	$14,662	$3,560	$11,102	4.12 to 1
at Kl & Lx	$14,703	$3,660	$11,043	4.02 to 1
at Kl & CR	$14,674	$3,590	$11,084	4.09 to 1
at Kl Lx & CR	$14,715	$3,690	$11,025	3.99 to 1
Single Stage SRS 1/				
	$17,193	$8,150	$9,043	2.11 to 1
Multi-Stage SRS 1/				
	$17,193	$8,450	$8,743	2.03 to 1
SRS + Minimal Levees 1/				
at Kelso only	$25,716	$8,290	$17,426	3.10 to 1
at Kl & Lx	$25,792	$8,390	$17,402	3.07 to 1
at Kl & CR	$25,758	$8,320	$17,438	3.10 to 1
at Kl Lx & CR	$25,834	$8,420	$17,414	3.07 to 1
SRS + Base-Plus Dredging + Minimal Levees 1/				
at Kelso only	$27,742	$9,380	$18,362*	2.96 to 1
at Kl & Lx	$27,783	$9,480	$18,303	2.93 to 1
at Kl & CR	$27,754	$9,410	$18,344	2.95 to 1
at Kl Lx & CR	$27,795	$9,510	$18,285	2.92 to 1

* Maximum net benefits.

1/ Includes $13,080,000 in benefits due to elimination of costs to maintain the base condition.

Conclusion: The NED plan is the SRS with base-plus dredging and minimal levee improvements at Kelso only. It has benefits of $27,742,000, costs of $9,380,000, and net benefits of $18,362,000. The benefit-to-cost ratio for this project is 2.96 to 1. Further studies will be conducted to determine if additional increases in SRS height can be more cost effective than downstream dredging after the SRS has reached capacity (i.e. filled with sediment). Preliminary studies indicate that under the expected sediment budget, the addition of two 25 foot stages, timed appropriately, would further reduce total project costs.

Incremental Justification: The NED plan must be viewed as a system which includes several measures. Each element of the NED plan must be incrementally justified (i.e. the incremental benefits derived from implementing each measure must be greater than the additional costs of that measure). The SRS with base level dredging is justified more than 2-to-1 over the base condition. It provides benefits of $17,193,000, costs of $8,150,000, and net benefits of $9,043,000. The addition of base-plus dredging to this plan increases benefits by $7,219,000 at an additional cost of $1,090,000 for an increase in net benefits of $6,129,000. The addition of minimal levee improvements at Kelso adds incremental average annual benefits of $3,330,000 at an additional average annual cost of $140,000 for an increase in average annual net benefits of $3,190,000.

It should be noted that the minimal levee improvements at Castle Rock and Lexington, which are justified if constructed separately, are not justified under the NED plan. This is because construction of an SRS coupled with incremental dredging provides enough additional protection at these sites to eliminate the justification for minimal levee improvements. Under the NED plan, the addition of minimal levee improvements at Castle Rock provides an increase in benefits of $12,000, but at a cost of $30,000, for a reduction in net benefits of $18,000. The addition of minimal levee improvements at Lexington would provide an increase in average annual benefits of $41,000, but at an average annual cost of $100,000, for a reduction in average annual net benefits of $59,000.

Comparison to No-Action: Thus far in this document all alternatives have been compared to the base condition, which is the without project condition in the absence of further action by the Federal Government. In this section, the most cost effective dredging, single stage, and multi-stage SRS alternatives are compared to the no-action condition. This is done to demonstrate that the NED plan would remain the same even if "no-action" was considered to be the without project condition. A comparison was made between the no-action condition and the base condition with minimal levee improvements at Kelso, Lexington, and Castle Rock, the intermediate dredging alternative with minimal levee improvements at Kelso only, the 125 foot SRS alternative with base plus dredging and minimal levee improvements at Kelso only (the NED plan), and the 125 foot MSRS with base level dredging and minimal levee improvements at Kelso and Castle Rock.

Damages under the no-action condition are $43,411,000. The base dredging alternative with minimal levee improvements at Kelso, Lexington and Castle Rock has residual damages of $4,194,000. The intermediate dredging alternative with minimal levee improvements at Kelso only has residual damages of $1,843,000. The single stage SRS with base-plus dredging and minimal levee improvements at Kelso only also has residual damages of $1,843,000. The MSRS, with minimal levee improvements at Kelso and Castle Rock, has residual damages of $3,827,000. Table C-23 lists damage reductions, costs, net benefits, and B/C ratios for these four alternatives when compared to no-action.

Based on the principle of maximum net benefits, the SRS alternative with base-plus dredging and minimal levee improvements at Kelso (the NED plan) is optimal when compared to the no-action scenario. This alternative has net benefits of $32,188,000 and a benefit-to-cost ratio of 4.43 to 1.

SENSITIVITY OF NED PLAN TO VARIATIONS IN SEDIMENT BUDGET

General

A level of uncertainty exists in projecting future conditions. This section addresses the most critical future projection in the decision document, the sediment budget, testing the NED plan, and two dredging alternatives, against variations in sediment projections.

TABLE C-23
COMPARISON OF ALTERNATIVES
TO THE NO-ACTION CONDITION
(dollars in thousands)

Alternative	Damage Reductions	Costs	Net Benefits	B/C Ratios
Base w/ 3 Levees	$39,217	$13,350	$25,867	2.94 to 1
Intermediate w/ 1 Levee	$41,568	$16,640	$24,928	2.50 to 1
SRS w/ Base Plus & 1 Levee	$41,568	$ 9,380	$32,188	4.43 to 1
MSRS w/ 2 Levees	$39,584	$ 8,620	$30,964	4.59 to 1

Methodology

The details of the estimated sediment budget (hereafter depicted as E) have been discussed previously in this report. The E budget is the current estimate of future sediment movement. Over 550 mcy are expected to be deposited in the Cowlitz and Toutle Rivers during the next 50 years. For comparative purposes, this sensitivity analysis looks at two other sediment projections that represent one-half the sediment budget (1/2 E) and 1-1/2 times the sediment budget (1-1/2 E).

This section examines the consequences for a chosen alternative when anticipating one budget and actually incurring a greater or lesser one. These effects are measured in terms of the average annual costs associated with construction of an alternative and the average annual residual damages expected to occur if that alternative is implemented. Together these costs represent the total costs incurred by society for implementation of a particular alternative.

A description is included of residual average annual flood damages and the costs of the SRS at Green River with base plus ddg SRS alternative for each sediment budget are $1.84 million. They do not vary with changes in the sediment budget since excess sediment would be dredged from the river channel downstream from the SRS.

If a budget different from E were anticipated, the best SRS plan would then be at a different height than 125 feet. If 1/2 E is expected, the SRS plan with the lowest costs to society would be an SRS of 100 feet with base-plus dredging and minimal levee improvements at Kelso only, while an SRS of 150 feet with base-plus dredging and minimal levee improvements at Kelso only would be the least cost plan for an expected budget of 1-1/2 E. Total plan costs vary with different actual budgets because of downstream action costs. With the E sediment budget, the AAC of the 100 foot SRS alternative would be $10.55 million, with 1/2 E these costs decline to $7.81, and with 1-1/2 E these costs increase to $17.17 million. The AAC of the 150 foot SRS with the same level of dredging and levee improvements would be $9.80 million for the E sediment budget, $8.90 million for the 1/2 E budget, and $13.99 million for the 1-1/2 E budget.

Costs and Flood Damages for the Dredging Alternatives

Dredging represents a flexible method for dealing with different sediment levels as initial fixed costs are held lower. As different levels of sediment migrate through the river system, they are dealt with to the extent practicable. For the E sediment budget, the intermediate dredging alternative provides residual damages similar to the NED plan. The AAC of this dredging alternative, including the cost of the minimal levee improvements at Kelso, is $5.35 million for the 1/2 E budget, $16.64 million for the E budget, and $26.20 million for the 1-1/2 E budget. The AAC of the base dredging alternative is $4.16 million for 1/2 E, $13.35 million for E, and $19.27 million for 1-1/2 E.

For the dredging alternatives, different levels of sediment deposition in the Cowlitz River associated with 1/2 E and 1-1/2 E will result in different residual average annual flood damages (AAD) than those shown for the E

budget. The AAD for the intermediate dredging alternative with the 1/2 E budget are $1.63 million, with E damages are $1.84 million, and with 1-1/2 E they are $2.43 million. With the E sediment budget, this alternative provides residual damages equal to those of the NED plan. The AAD with the base dredging alternative are $3.86 million for the 1/2 E budget, $4.19 million for the E budget, and $4.68 million for the 1-1/2 E budget. The intermediate dredging alternative is the most cost-effective dredging alternative for the 1/2 E sediment budget; the base dredging alternative is the most cost-effective dredging alternative for the E and 1-1/2 E sediment budgets.

Comparison of Dredging and SRS

Table C-24 presents the results of the sensitivity analysis. This matrix shows nine possible combinations of structure design and sediment budget, and the resulting costs and damages of incurring one of these budgets. Each block in Table C-24 compares the total costs to society (AAD plus AAC) for the SRS alternative, including the NED plan, and the two dredging alternatives. By comparing the sum of AAC and AAD in each block, the total cost incurred by society for adopting a particular alternative can be identified, given a particular sediment budget.

In all cases, if the 1/2 E budget actually occurs, the intermediate dredging alternative is the least costly plan. It saves $2.67 million over the 100 foot SRS option ($9.65-$6.98 million), $2.75 million over the 125 foot SRS option ($9.73-$6.98 million), $3.76 million over the 150 foot SRS option ($10.74-$6.98 million), and $1.04 million over the base dredging alternative ($8.02-$6.98 million).

If the E or 1-1/2 E budgets actually occur, the most cost-effective plan is an SRS alternative. If the E budget actually occurs, the 125 foot SRS alternative is the most cost-effective plan. It saves $6.32 million over the base dredging plan ($17.54-$11.22 million) and $7.26 million over the intermediate dredging alternative ($18.48-$11.22 million). If the 1-1/2 E budget actually occurs, the 150 foot SRS is the least costly plan. It saves $9.96 million over the base dredging alternative ($23.95-$13.99 million) and $14.64 million over the intermediate dredging alternative ($28.63-$13.99 million).

Table C-24
Sensitivity Matrix
Average Annual Costs plus Average Annual Damages
(in millions of dollars)

Actual Budget	Design for: SRS @ 100 ft. 1/2 E		SRS @ 125 ft. E		SRS @ 150 ft. 1-1/2 E	
	SRS-AAC	7.67	SRS-AAC	7.75	SRS-AAC	8.76
	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	1.84	AAD	1.84	AAD	1.84
	Total	9.65	Total	9.73	Total	10.74
	Int Drg-AAC	5.21	Int Drg-AAC	5.21	Int Drg-AAC	5.21
1/2 E	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	1.63	AAD	1.63	AAD	1.63
	Total	6.98	Total	6.98	Total	6.98
	Base Drg-AAC	3.89	Base Drg-AAC	3.89	Base Drg-AAC	3.89
	3 Levees-AAC	0.27	3 Levees-AAC	0.27	3 Levees-AAC	0.27
	AAD	3.86	AAD	3.86	AAD	3.86
	Total	8.02	Total	8.02	Total	8.02
	SRS-AAC	10.41	SRS-AAC	9.24	SRS-AAC	9.66
	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	1.84	AAD	1.84	AAD	1.84
	Total	12.39	Total	11.22	Total	11.64
	Int Drg-AAC	16.50	Int Drg-AAC	16.50	Int Drg-AAC	16.50
E	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	1.84	AAD	1.84	AAD	1.84
	Total	18.48	Total	18.48	Total	18.48
	Base Drg-AAC	13.08	Base Drg-AAC	13.08	Base Drg-AAC	13.08
	3 Levees-AAC	0.27	3 Levees-AAC	0.27	3 Levees-AAC	0.27
	AAD	4.19	AAD	4.19	AAD	4.19
	Total	17.54	Total	17.54	Total	17.54
	SRS-AAC	17.03	SRS-AAC	12.93	SRS-AAC	12.01
	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	1.84	AAD	1.84	AAD	1.84
	Total	19.01	Total	14.91	Total	13.99
	Int Drg-AAC	26.06	Int Drg-AAC	26.06	Int Drg-AAC	26.06
1-1/2 E	1 Levee-AAC	0.14	1 Levee-AAC	0.14	1 Levee-AAC	0.14
	AAD	2.43	AAD	2.43	AAD	2.43
	Total	28.63	Total	28.63	Total	28.63
	Base Drg-AAC	19.00	Base Drg-AAC	19.00	Base Drg-AAC	19.00
	3 Levees-AAC	0.27	3 Levees-AAC	0.27	3 Levees-AAC	0.27
	AAD	4.68	AAD	4.68	AAD	4.68
	Total	23.95	Total	23.95	Total	23.95

Since the estimate of sediment movement is E, the following discussion examines the consequences of designing for this budget. If a 125 foot SRS is constructed in anticipation of the E budget and only 1/2 E occurs then society would incur an additional cost of $2.75 million over the most cost-effective dredging alternative (intermediate dredging). If an E budget actually occurs then society would save $6.32 million over the most cost-effective dredging option (base dredging). If the 1-1/2 E budget occurs then savings over base dredging would be $9.04 million in terms of AAC + AAD.

If 1/2 the E budget is expected, then the most cost-effective alternative is intermediate dredging. Assuming this budget actually occurs, the intermediate dredging alternative would save $1.04 million in AAC + AAD over the base dredging alternative and $2.67 million over the 100 foot SRS alternative. If the 1/2 E budget was expected and the E budget actually occurred, the intermediate dredging alternative would cost society $.94 million more than the base dredging alternative and $6.09 million more than the 100 foot SRS alternative. If the 1/2 E budget were expected and the 1-1/2 E budget actually occurred, the intermediate dredging would cost society $4.68 million more than the base dredging alternative and $9.62 million more than the 100 foot SRS alternative.

If the 1-1/2 E budget is expected, a 150 foot SRS is the most cost-effective alternative. Assuming the 1-1/2 E budget actually occurs, the 150 foot SRS alternative has $9.96 million less in AAC + AAD than the base dredging alternative and $14.64 million less in AAC + AAD than the intermediate dredging alternative. If 1-1/2 E is expected and E actually occurs, the 150 foot SRS alternative would provide savings of $5.90 million over the base dredging alternative and $6.84 million over the intermediate dredging alternative. If the 1-1/2 E sediment budget were expected and the 1/2 E budget actually occurred, the 150 foot SRS would cost society $2.72 million more than the base dredging alternative and $3.76 million more than the intermediate dredging option.

The break even point for the percentage of the sediment budget that would have to occur to produce the same costs for the most cost-effective dredging alternatives and SRS alternatives is shown on Figures C-9 through C-11 for each design scenario. Figure C-10 shows that if the 125-foot SRS option were built, it would have lower costs and damages than the most cost-effective

dredging alternative as long as .64 E, or a volume in excess of .64 E occurs. Figures C-9 and C-11 display the same information for the 100 foot SRS option (.65 E) and 150 foot SRS option (.68 E) respectively. Figure C-12 shows that if the optimal SRS plan is chosen for a given sediment load, the SRS will be preferable to the most cost-effective dredging alternative as long as sediment volume in excess of .63 E occurs.

Conclusion of the Sediment Budget Sensitivity Analysis

If the NED plan discussed in this report were implemented in anticipation of the E budget, and 1/2 E actually occurs, then the least costly alternative was not chosen. However, if the NED plan were built and .64 E or sediment in excess of 64 E occurs, then the NED plan represents a less costly alternative than long-term dredging.

RISK ANALYSIS - EXTREME EVENTS

General

The first component of the sensitivity analysis demonstrated the relative advantages of the Green River SRS and two dredging alternatives for different levels of sediment movement. The sensitivity analysis concentrated on each plan's effectiveness in dealing with projected average annual movement of sediment. As explained in Appendix A, actual movement of sediment over time is expected to vary widely from the average annual condition. The remainder of this sensitivity section describes the risks associated with events generating greater than average sediment movements. Two alternatives are evaluated, the SRS with base plus dredging and minimal levee improvements at Kelso only (referred to as the "SRS alternative" in this section), and base dredging with minimal levee improvements at Kelso, Lexington, and Castle Rock (referred to as the "dredging alternative" in this section).

Since it is impossible to predict the timing of non-typical hydrologic events, they are not included in the evaluation process. This section demonstrates that the dredging option is more sensitive than the NED plan to extreme sediment transport events and their associated risks of increased flood damages. Selection of the best plan must consider risks associated with large atypical events.

FIGURE C-9

SENSITIVITY OF ALTERNATIVES
DESIGN FOR 1/2 E
(1985 PRICES)

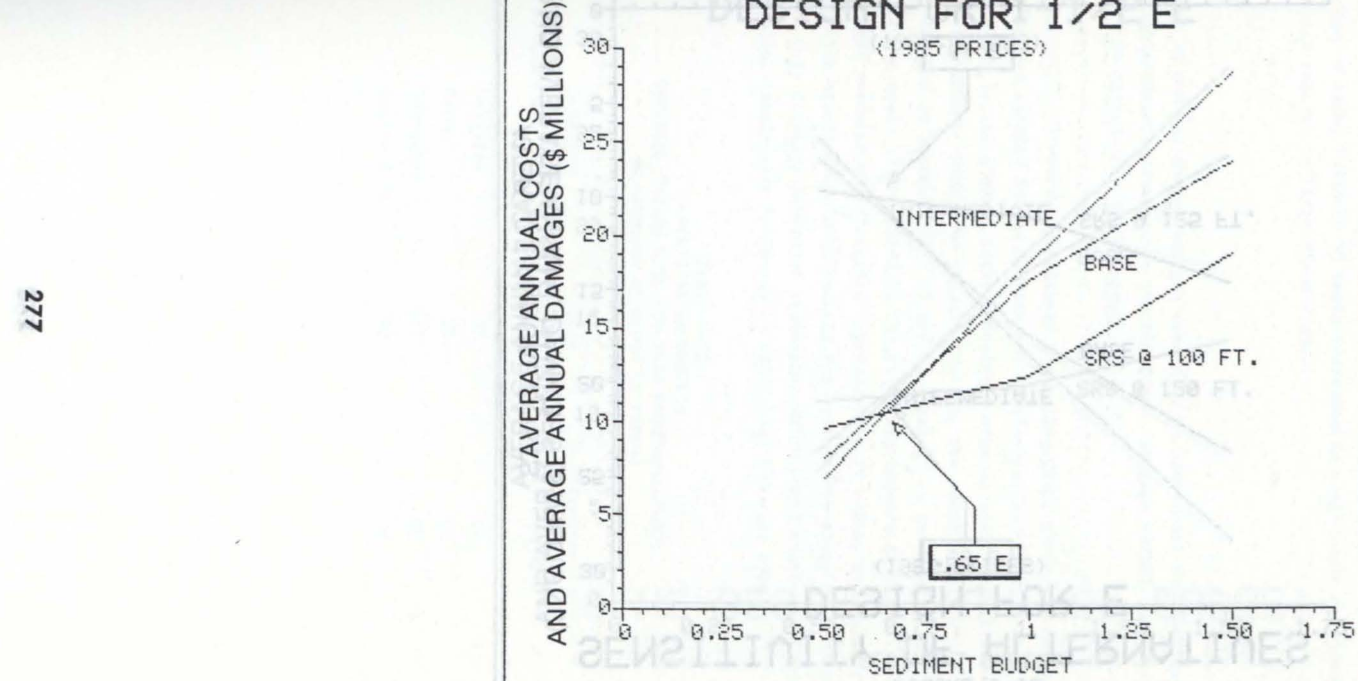


FIGURE C-10

SENSITIVITY OF ALTERNATIVES
DESIGN FOR E
(1985 PRICES)

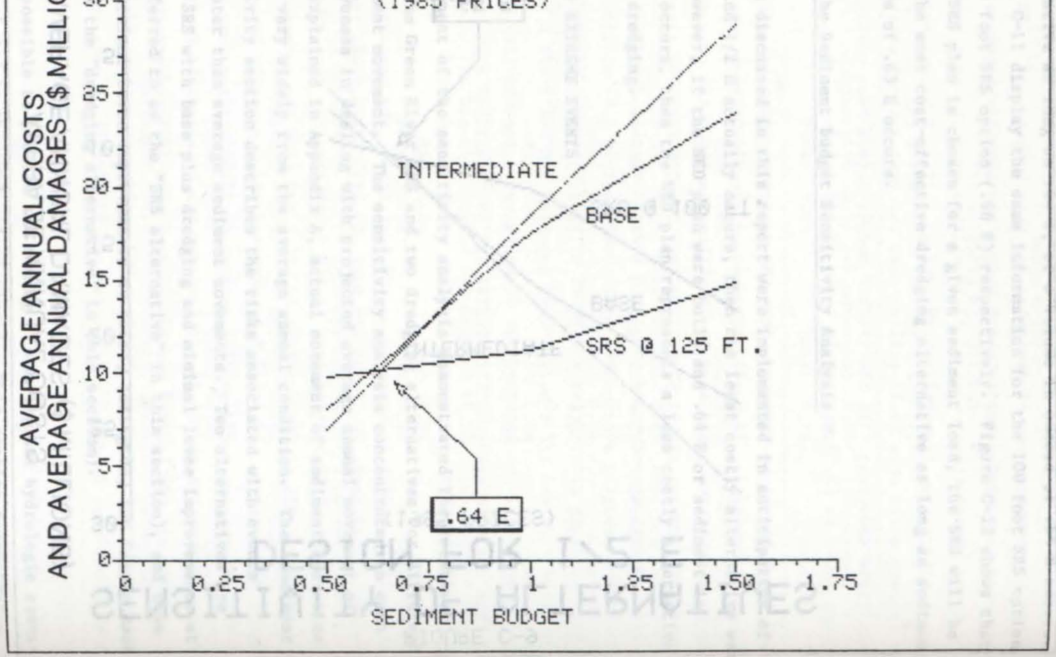


FIGURE C-11

SENSITIVITY OF ALTERNATIVES DESIGN FOR 1-1/2 E

(1985 PRICES)

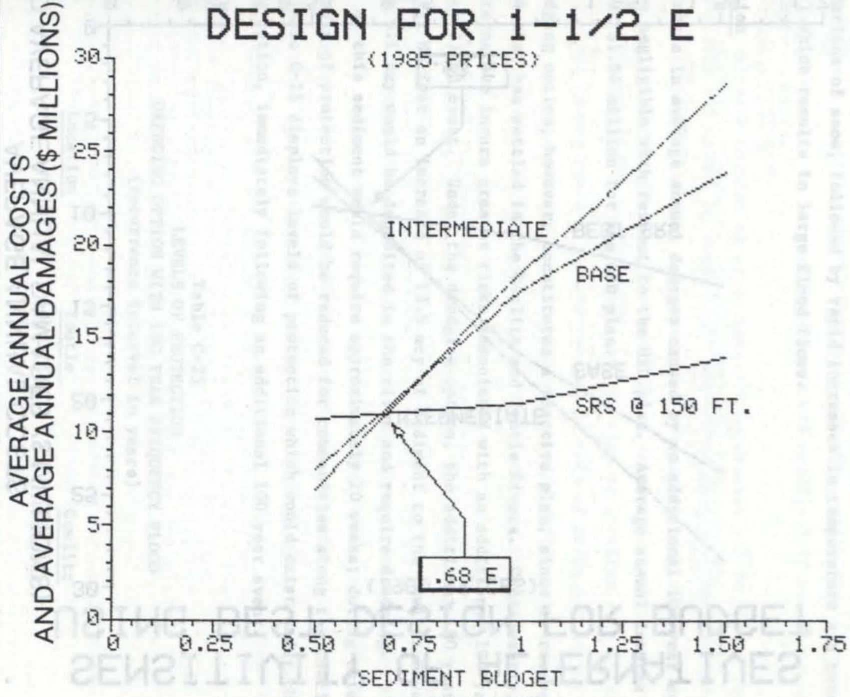
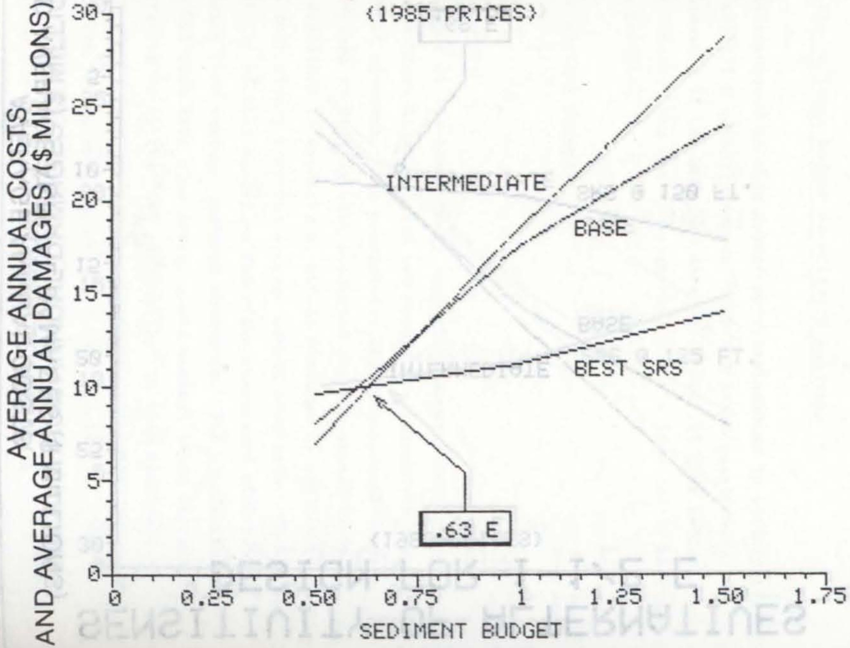


FIGURE C-12

SENSITIVITY OF ALTERNATIVES USING BEST DESIGN FOR BUDGET

(1985 PRICES)



Methodology

The risks associated with a large sediment movement are demonstrated by comparing the effects of a 100 year frequency storm event, in addition to average annual hydrologic events, on the NED plan and the dredging option. Rare frequency events in the Toutle basin are usually caused by large accumulations of snow, followed by rapid increases in temperature and heavy rainfall which results in large flood flows.

Evaluation

The increase in average annual damages caused by an additional 100 year event would be negligible with respect to the NED plan. Average annual damages remain at $1.84 million for the NED plan.

The dredging option, however, constitutes a reactive plan, since it removes sediment that has settled in the Cowlitz and Toutle Rivers. Consequently, this alternative incurs greater risks associated with an additional 100 year frequency flood event. Under the dredging option, the additional 100 year event will deliver an increase of 13.5 mcy of sediment to the Cowlitz River, of which 5.1 mcy would be deposited in the river and require dredging. Removal of this sediment would require approximately 20 weeks; during this time levels of protection would be reduced for communities along the Cowlitz River. Table C-25 displays levels of protection which would exist under the dredging option, immediately following an additional 100 year event.

Table C-25
LEVELS OF PROTECTION
DREDGING OPTION WITH 100 YEAR FREQUENCY FLOOD
(recurrence interval in years)

Location	Toutle 1987-1998	Cowlitz 1999-2035
Longview	71	61
Kelso	56	51
Lexington	111	91
Castle Rock	33	8

Timing of an additional 100 year event is critical to the assessment of risk. For example, if the event occurred during late fall to spring, the Cowlitz River could not be dredged in time to restore channel conditions for the remaining flood season, substantially increasing the flood risk. Flood water elevations would remain higher and protection levels would remain lower than the average annual condition. During this time, average annual damages would increase from $4.2 million (dredging option) to $7.3 million. Average annual damages remain at $1.8 million for the NED plan.

The cost impact of the additional 100 year event is related directly to available storage remaining behind the SRS. Costs to dredge the additional sediment would be deferred to the out-years, and possibly beyond the 50-year life of the project. The base condition would incur increased average annual damages of $3.1 million, as well as the cleanup costs of increased sediment in the river at the point in time of the occurrence. Average annual costs cannot be determined for either alternative because they are dependent on the year in which the flood event occurs. Therefore, these costs were not estimated.

Conclusion

The dredging option is more sensitive to additional low frequency flood events than the NED plan. If an additional low frequency flood occurs, levels of protection will remain the same under the SRS option, but will decrease significantly for the dredging alternative until a base level of protection can be restored.

MOUNT ST. HELENS SEDIMENT CONTROL, WASHINGTON (TOUTLE, COWLITZ, AND COLUMBIA RIVERS)

REPORT OF CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO ATTENTION OF:
DAEN-CWP-A

April 3, 1985

SUBJECT: Mount St. Helens Sediment Control, Washington (Toutle, Cowlitz, and Columbia Rivers)

THE SECRETARY OF THE ARMY

1. I submit, for transmission to Congress, my report on Mount St. Helens Sediment Control, Washington. It is accompanied by the reports of the Board of Engineers for Rivers and Harbors and the District and Division Engineers. These reports are in response to the President's Memorandum to the Secretary of Defense, dated May 18, 1982, and the subsequent report to the President entitled "A Comprehensive Plan for responding to the Long-term Threat Created by the Eruption of Mount St. Helens, Washington," dated November 7, 1983, and conducted under the authority of Section 216 of the Flood Control Act of 1970.

2. The District and Division Engineers considered various strategies, including limited permanent evacuation, stabilization basins, retention structures, and dredging to identify the best alternative to provide a long-term solution to the flooding and navigation problems resulting from sedimentation in the Toutle, Cowlitz, and Columbia Rivers. They recommend the implementation of a Federal project for flood damage and navigation maintenance reduction. This preferred plan consists of a single retention structure and associated downstream actions. Through continuous monitoring, additional information will be obtained about the rate and future magnitude of sediment deposition. If up-to-date analysis of sediment deposition and of benefits and costs of alternatives provides compelling and convincing reasons, the selection of another alternative, such as a staged single retention structure or dredging, may be warranted. Accordingly, concurrent analysis and design of single retention structure, staged single retention structure, and dredging alternatives will continue. The reporting officers recommend authorization of the three alternatives.

3. The estimated Federal first cost of the preferred plan, based on October 1984 prices, an interest rate of 8-3/8 percent, and a 50-year period for economic analysis, is $197,200,000. The non-Federal first cost of the preferred plan is currently estimated at $16,900,000 and the estimated annual operation and maintenance cost is $75,000. Average

annual operation, maintenance, and sediment monitoring costs to the United States are estimated at $975,000, excluding the costs of maintaining the existing Federal navigation channel in the Columbia River. The average annual benefits are estimated to be $28,000,000, and the benefit-cost ratio is 1.5 to 1 for this preferred plan, which is also the current National Economic Development (NED) plan.

4. The Board of Engineers for Rivers and Harbors concurs, in general, in the conclusions and recommendations of the reporting officers. In its review of the reporting officers documents, the Board noted both the serious scope of the flood threat to the communities along the Cowlitz River and to the increasing cost of maintaining its navigation depths in the Columbia River. The Board also notes that the scope of mitigation responsibilities of the United States is appropriately limited to those impacts directly related to the proposed work.

5. The Board recommends authorization of a sediment control project for flood damage and navigation maintenance reduction on the Toutle, Cowlitz, and Columbia Rivers, generally in accordance with the reporting officers preferred plan, designated as the NED plan, with such modifications as in the discretion of the Chief of Engineers may be advisable, such as provisions to raise the single retention structure should conditions warrant. The Board also recommends sufficient authorization flexibility to implement either a single retention structure, a staged single retention structure, or dredging if future studies warrant such a course of action.

6. I have carefully reviewed the reports of the District and Division Engineers and the Board of Engineers for Rivers and Harbors and concur in their findings and conclusions. The unstable nature of the Mount St. Helens and Toutle-Cowlitz river system introduces a large element of uncertainty into any decision for a long-range solution. I note that the sensitivity studies carried out by the reporting officers identify the single retention structure as the preferred plan. Two other plans, the staged single retention structure and dredging, may become the preferred plan under different conditions. In light of this considerable uncertainty, concurrent analysis and design of the single retention structure, the staged single retention structure, and dredging will continue. At this time, however, the best technical judgment considers the single retention structure as the best solution to the sediment problems resulting from the eruption of Mount St. Helens.

7. I generally concur in the recommendations of the Board and recommend the construction of a single retention structure near the confluence of the Toutle and Green Rivers with associated downstream actions. I note that modifications that may be advisable are within the discretion of the Chief of Engineers except that the Secretary of the Army may select and implement a staged single retention structure or dredging if he determines that further analysis of benefits and costs or further sediment monitoring provide compelling and convincing new evidence to justify selection of another alternative.

8. The recommendations contained herein reflect the information available at this time and current Department policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

E. R. HEIBERG III
Lieutenant General, USA
Chief of Engineers

DEPARTMENT OF THE ARMY
BOARD OF ENGINEERS FOR RIVERS AND HARBORS
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

REPLY TO
ATTENTION OF:

BERH-PLN January 9, 1985

SUBJECT: Mount St. Helens Sediment Control, Washington
(Toutle, Cowlitz, and Columbia Rivers)

Chief of Engineers
Department of the Army
Washington, DC 20314-1000

Summary of Board Action

The Board concurs in the recommendations of the reporting officers for solving long-term volcanic sediment problems associated with the eruption of Mount St. Helens, Washington. The proposed improvements consist of a single retention structure on the North Fork Toutle River just upstream of the mouth of the Green River, along with continued dredging and associated downstream actions on the Toutle and Columbia Rivers. The total project first cost of the preferred plan is estimated at $292,200,000, of which $16,900,000 would be non-Federal and $33,100,000 would be Federally funded under the existing Columbia River Navigation Program. The benefit-cost ratio is 1.5. The Board also concurs with the reporting officers' desire for sufficient flexibility in project authorization so as to implement either a single retention structure, a staged single retention structure, or dredging alternative if future studies warrant such course of action. The Board recommends the plan subject to cost-sharing and financing arrangements satisfactory to the President and the Congress.

Summary of Report Under Review

1. Authority. This report is in response to a recommendation by the Assistant Secretary of the Army, Civil Works, in a 3 November 1983 Memorandum for the President, subject: Mount St. Helens - Solutions to Long-Term Problems. The memorandum stated: "With respect to the control of sediment, the Corps should complete the planning necessary to recommend Congressional authorization and funding of a permanent solution. Planning and design should concentrate on the retention structure alternatives with the goal of early construction of a retention structure (staged or otherwise) at the lowest feasible site. Other stages or upstream structures should be planned for subsequent construction if and when needed. These feasibility plans will be reviewed at the Division and Office of the Chief of Engineers level, as well as the Board

of Engineers for Rivers and Harbors, before being submitted to the Secretary of the Army for approval and transmittal to the Congress."

2. Description of study area. The study area covers 1,200 square miles in southwest Washington, extending north from the Columbia River to the Toutle River headwaters at Mount St. Helens. The Columbia River reach most affected by volcanic sediment is between river miles (RM) 0 and 72. Lands along the rivers consist of a narrow valley bottom adjacent to low hills. Also included in the study area is the lower 20 miles of the Cowlitz River from its junction with the Columbia River at RM 68.7 to the mouth of the Toutle River. This reach of the Cowlitz River flows past the towns of Castle Rock, Lexington, Longview, and Kelso, Washington, all major population centers of the study area. The three major tributaries of the Toutle River are the North and South Forks and the Green River. The North and South Forks Toutle River have their headwaters on the slopes of Mount St. Helens and carry runoff and sediment westward to the Cowlitz River. Included in the North Fork Toutle River subbasin are three lakes: South Castle, Coldwater, and Spirit. The terrain of the Cowlitz and Toutle Rivers subbasin is mountainous and heavily forested except for clearcuts and areas devastated by the 1980 eruption.

3. Background.

a. Mount St. Helens eruption. Earthquakes of increasing frequency and intensity occurred in the area around Mount St. Helens in March 1980. A crater formed on the mountaintop, permitting eruption of steam, ash, and large rock. Early on 18 May 1980, an earthquake shook the mountain and its north side collapsed toward Spirit Lake and the North Fork Toutle River. An eruption followed with the release of superheated gasses, ash, and rock. Nearly all vegetation was destroyed in a 156-square-mile area north and west of the mountain. Hot gasses killed trees as far away as 17 miles. Debris from the blast crossed the ridge north of Spirit Lake and into the Green River drainage basin. Billions of gallons of water released from snow and glacial ice picked up ash and debris and formed major mudflows. These mudflows moved down both forks of Toutle River and its mainstem, into the Cowlitz River and to the Columbia River - a distance of about 70 miles. A smaller mudflow followed Pine Creek down the southeast flank of the mountain. All river channels were filled with ash and debris. Flooding on the Toutle and Cowlitz Rivers threatened 45,000 people living along the lower 20 miles of Cowlitz River. Blockage of the Columbia River navigation channel and stranding of deep-draft vessels meant the loss of millions of dollars per day to the region.

b. Emergency measures. Immediately following the 18 May eruption of Mount St. Helens, the U.S. Army Corps of Engineers initiated emergency action under Public Law (P.L.) 84-99 to restore navigation on the Columbia River and to reduce the flood damage threat to communities along the Cowlitz River. Through fiscal year 1983, emergency activities by the Corps totaled $327 million.

c. Comprehensive study. In response to an 18 May 1982 memorandum from the President, a report on a comprehensive plan for responding to the long-term threat created by the 1980 eruption of Mount St. Helens was completed by the U.S. Army Corps of Engineers on 2 November 1983. That report presented several management strategies for addressing a range of sediment erosion and deposition rates. The report also presented several alternatives for establishing a permanent outlet for Spirit Lake. In his 3 November 1983 memorandum to the President, the Assistant Secretary of the Army, Civil Works, recommended construction of a permanent outlet for Spirit Lake. He also recommended proceeding with the planning necessary to recommend Congressional authorization and funding of a permanent sediment control solution. Other recommendations included proceeding with public involvement in the development of plan recommendations, continuing emergency measures for control of Spirit Lake levels, and continuing downstream emergency flood protection work.

d. Decision document on Spirit Lake. To facilitate early action planning, a decision document recommending a specific tunnel alignment for control of water levels at Spirit Lake was completed in February 1984. Construction of the Spirit Lake outlet works is underway and completion is scheduled for April 1985.

4. Existing improvements and emergency actions.

a. Federal improvements. Federal navigation projects in the study area include the Columbia River project, which provides for a 40-foot-deep and 600-foot-wide channel from the mouth of the Columbia River to RM 105.5. The active portion of the Federal navigation project on the Cowlitz River provides for a channel 8 feet deep and 100 feet wide from its junction with the Columbia River upstream for 4.2 miles. Thence, the channel is 4 feet deep and 50 feet wide to RM 9, and 2.5 feet deep and 40 feet wide to above the confluence of the Toutle River. Pertinent flood control projects include Federally constructed and/or improved levees at Longview, Kelso, Lexington, and Castle Rock, Washington.

b. Federal emergency actions. Emergency actions within the study area have been undertaken by several Federal agencies. Under authority of P.L. 84-99, the U.S. Army Corps of Engineers activities included (a) raising and strengthening levees at Castle Rock, Lexington, Longview, and Kelso, (b) excavating the Cowlitz River and lower Toutle River channels to reestablish flood flow capacity, (c) providing bank erosion protection where volcanic sediment had altered the stream channel, (d) acquiring flood control storage at an existing private power company reservoir, (e) constructing debris retention structures on the North and South Forks Toutle River to reduce sediment inflow to the Cowlitz River, (f) excavating eight sediment stabilization basins along the North and South Forks and the main stem Toutle River by widening and deepening reaches of the rivers, (g) constructing outlet channels at several upstream lakes, (h) constructing a 1 million cubic yard capacity sump at the mouth of the Cowlitz River to reduce sediment inflow to the Columbia River, (i) dredging to reestablish and maintain authorized navigation depths, and (j) implementing an interim emergency pumping operation at Spirit Lake to prevent overtopping of the volcanic sediment embankment blocking the lake.

c. Non-Federal improvements. Local interests maintain both agricultural and urban levee systems in the study area. In addition, an extensive network of highways, railroads, major industrial, and other developments are located in the floodplain, but are not protected by any levees.

d. Non-Federal emergency actions. Local governments implemented emergency communication, warning, and evacuation programs several months before the May 1980 volcanic eruption. These programs have been expanded and continue to provide flood warning and other assistance. State and local governments purchased and provided lands for dredged material disposal and rights-of-way and easements for Federal emergency operations. County and local governments have expended nearly $8 million from March 1980 to December 1983 as a result of the Mount St. Helens eruption.

5. Problems and needs. Continued in-stream transport and deposition of highly erodible volcanic sediment is increasing both the flood threat in urban floodplain areas and the cost of maintaining navigation channels. In the absence of a permanent solution to volcanic sediment problems, dredging and emergency flood protection costs will continue to increase as land costs for disposal of excavated materials and other operational costs increase.

6. Improvements desired. Several public meetings were held to consider strategies designed to solve the sediment problem. Public opinion generally supported a solution which would retain sediment as far upstream as possible in the Toutle River. State and local governments and the majority of local citizens prefer construction of a single retention structure at the Green River site as the best solution to the volcanic sediment control problem.

7. Alternatives considered. Major alternatives considered by the District Engineer included a permanent evacuation plan, dredging of sediment stabilization basins or sumps, construction of multiple retention structures--both with and without removal of trapped sediment, and construction of single retention structures. All alternative plans also included varying dredging requirements for maintaining a 40-foot-deep channel on the Columbia River.

8. Plan of improvement. The District Engineer's preferred plan involves construction of a single retention structure (SRS) on the North Fork Toutle River just upstream of the confluence of the Green River, along with dredging on the Toutle, Cowlitz, and Columbia Rivers. The retention structure that maximizes net National Economic Development (NED) benefits would be 177 feet high. The structure would provide storage for 299 million cubic yards (m.c.y.) of material anticipated to be deposited during the 50-year period of analysis. Sediment and debris would be trapped behind the structure, while water would pass over a spillway or through an outlet works. Approximately 7,500 acres of land would be acquired for construction of the SRS. Dredging would occur at two sites on the Toutle River and in the Columbia River. Toutle River dredging sites are natural deposition areas which have been used for past emergency actions following the 1980 eruptions, and it is expected that 29 m.c.y. of sediment would be dredged from these two sites over the 50-year period of analysis. Columbia River navigation maintenance dredging during the 50-year period of analysis would include an estimated 15 m.c.y. of additional volcanic sediment over pre-eruption dredging requirements. However, this work would be funded and accomplished under existing authorities for Columbia River navigation maintenance. Provision of all land, easements and rights-of-way required for both construction of the SRS and downstream dredging operations would be a non-Federal responsibility. Project related mitigation responsibilities would be limited to providing fish bypass facilities at the SRS.

9. Economic evaluation. At October 1984 price levels, the District Engineer's preferred plan has an estimated first cost of $292,200,000 of which $16,900,000 would be non-Federal and

$33,100,000 would be Federally funded under existing maintenance authority for Columbia River navigation. Average annual charges, using an interest rate of 8-1/8 percent and a 50-year period for economic analysis, are estimated at $17,900,000, including $925,000 for Federal and $75,000 for non-Federal annual operation and maintenance. Average annual benefits are estimated at $27,800,000 and the benefit-cost ratio is 1.6.

10. Project impacts. Implementation of the preferred NED plan would save $23.3 million annually in dredging costs on the Cowlitz and Columbia Rivers and would prevent $4.5 million in average annual flood damages to development along the Cowlitz River. The preferred plan would also provide for maximum preservation and enhancement of the lower Toutle River and Green River fisheries as compared to other alternative actions.

11. Recommendations of the reporting officers. The District Engineer recommends authorization for construction of a single retention structure and associated downstream actions for controlling sediment deposition in the Toutle, Cowlitz, and Columbia Rivers, Washington, generally in accordance with the preferred plan described in his report and with such modification as the Chief of Engineers deems advisable, such as provisions to raise the structure, should future conditions warrant. The District Engineer notes that through continuous monitoring, additional information will be obtained on the rate and future magnitude of sediment transport and deposition. If up-to-date sediment analysis and corresponding analysis of benefits and costs of alternatives provide compelling and convincing reasons, selection of another alternative, such as a staged single retention structure or dredging, may be warranted. Therefore, the District Engineer also recommends that project authorization be sufficiently flexible to allow implementation of either a single retention structure, a staged single retention structure, or dredging. The Division Engineer concurs.

Review by the Board of Engineers for Rivers and Harbors

12. General. The Board's review encompassed the overall technical, economic, social, policy, and environmental aspects of the recommended plan, including whether the report and its supporting documentation conformed to the Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. The Board gave particular attention to the assumptions inherent in determination of the: base or without-project condition; basis and accuracy of the sediment transport and deposition estimate; formulation and sensitivity of the selected National Economic

Development (NED) Plan; rationale and justification for fish and wildlife mitigation; and the potential project cost sharing.

13. The Board notes both the serious scope of the present flood threat to communities along the Cowlitz River and the increasing cost of maintaining needed navigation depths on the Columbia River due to uninterrupted sediment transport and deposition. The Board further notes that the threat to life and property and the continuing high cost of emergency measures require expedited authorization and implementation of a plan.

14. Public response to draft report and environmental impact statement. The reporting officers received 123 letters during the review and comment period on the draft report and EIS. Thirty-three letters were from agencies and businesses expressing support for the preferred SRS plan. However, some local governments were opposed to cost-sharing provisions recommended by the District Engineer. The Governor of the State of Washington indicated support for the SRS and reiterated his preference for application of the traditional cost-sharing formula. The Governor believed that operation and maintenance of the proposed fish bypass features should be a Federal responsibility and that other mitigation measures should be considered during construction of the project. The U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency urged consideration of a more comprehensive program for fish and wildlife and general environmental mitigation. Ninety-one letters were from individuals in the study area, twelve of which expressed opposition to the proposed project. While the majority of individuals favor the proposed project, most oppose the recommended cost sharing.

15. Findings and conclusions.

a. Base condition. Over $327 million in Federal funds have been expended by the U.S. Army Corps of Engineers in alleviating effects of the May 1980 Mount St. Helens eruption; and other Federal, State, and local agencies and private interests have spent many million dollars more. Public Law 98-63 and other authorities support a continued commitment of emergency and interim measures to solve volcanic sediment problems in the absence of any permanent solution. The Board notes the limited capability of the emergency levee improvements to provide permanent flood protection.

b. Sediment estimate. The Board notes that there have been numerous studies by the U.S. Army Corps of Engineers, other government agencies, universities, and consultants on the movement and deposition of sediment resulting from the eruption

of Mount St. Helens. The best expertise and resources available have been used in development of the sediment transport and deposition estimate, the results of which are fundamental to the study problem statement and to the evaluation of alternative solutions. Nevertheless, the Board recognizes that specific experience in volcanic sediment erosion and transport for Mount St. Helens is limited and that continued sediment monitoring and analysis are needed. The Board believes that such monitoring and analysis should continue with a view to predicting the adequacy of the proposed sediment retention storage.

c. NED plan. The Board concurs with the reporting officers' selection of a 177-foot high SRS at the Green River site as the plan which maximizes net NED benefits. Based on predicted sediment yields, the selected plan is the most cost-effective means of solving the sediment-related flood damage and navigation problems. In addition, the reporting officers' sensitivity analyses show that sediment yields would need to be as much as 35 percent less than predicted before other alternatives would become equally cost effective. Analyses also show that if sediment yields increase above predictions, the cost effectiveness of the selected NED plan improves as compared to other alternatives.

d. Contingency provision. The Board believes that the cost-effectiveness of the selected plan through a wide range of sediment estimates is an important attribute, in view of the uncertainties in future sediment erosion and transport. However, a rare flood event, excessive mudflow, and/or successive years of high sediment inflow could occur, and the available storage in the proposed SRS could be seriously diminished. The ability to quickly respond to such an emergency condition by increasing the dam height, or by other related measures, could be imperative. In addition, with continued sediment monitoring and analysis, additional information will be obtained on the rate and future magnitude of sediment deposition. The reporting officers have indicated that selection of another alternative (such as a staged retention structure or dredging) may be warranted if additional analyses provide compelling and convincing reasons for such action. They intend to continue concurrent analysis and design of a single retention structure, staged single retention structure, and dredging alternatives. The Board concurs with the reporting officers' desire for sufficient flexibility in project authorization to implement one of these alternatives if conditions warrant. Accordingly, the Board believes that the proposed project should be authorized with the provision to allow the Secretary of the Army, acting through the Chief of Engineers, the discretionary authority to increase the storage capacity of the

SRS by raising the retention structure height or to provide other alternatives to a single stage SRS if conditions warrant.

e. Environmental assessment and mitigation. The Board notes that the scope of any mitigation responsibilities of the U.S. Army Corps of Engineers has been appropriately limited to those impacts directly related to the proposed SRS. Mitigation of impacts on the natural environment due to the initial volcanic eruption and to subsequent emergency work have not been considered to be a project related responsibility. The Board believes that the recommended fish and wildlife mitigation responsibility is equitable, with the Federal government assuming the initial cost of fish transfer facilities associated with the SRS and the State of Washington providing for operation and maintenance of the transfer program and facilities. No other fish and wildlife mitigation measures appear to be justified at this time. In addition, the Board carefully considered the comments of the Governor of the State of Washington relative to state assumption of operation and maintenance of fish transfer facilities. The Board notes that this represents a departure from cost-sharing arrangements associated with fish and wildlife mitigation at other water resource development projects located in the state. However, control of sediments in the overall Toutle-Cowlitz-Columbia River System will significantly hasten the restoration of anadromous fisheries habitat, and studies to date have not taken full credit for these positive effects. Accordingly, the Board believes that the assumption by the Federal government of first costs for construction of fish passage facilities (estimated at $1 million), with assumption of operation and maintenance costs (estimated at $75,000 per annum) by the State of Washington, is reasonable and equitable.

16. Project first costs, based on October 1984 price levels, are estimated to be $292,200,000 of which $16,900,000 would be non-Federal and $33,100,000 would be Federally funded under existing maintenance authority for Columbia River navigation. Average annual charges, using an interest rate of 8-3/8 percent and a 50-year period for economic analysis, are estimated at $18,300,000, including $925,000 for Federal and $75,000 for non-Federal annual operation and maintenance. Average annual benefits are estimated at $28,000,000 and the benefit-cost ratio is 1.5.

17. Recommendations.

a. The Board recommends authorization of a volcanic sediment control project for flood damage and navigation maintenance reduction on the Cowlitz, Toutle, and Columbia Rivers, Washington, generally in accordance with the reporting officers' preferred plan, with such modification as in the discretion of the Chief of

Engineers may be advisable, such as provisions to raise the single retention structure should future conditions warrant, and in accordance with cost-sharing and financing arrangements satisfactory to the President and the Congress.

b. The Board recommends that the authorization contain sufficient flexibility to implement either a single retention structure, a staged single retention structure, or dredging alternatives if future studies warrant such course of action.

c. The Board further recommends that as a part of project authorization, the Federal Government and its contractors or agents be exempt from all Washington State and local sales, use, and associated excise taxes (Chapters 82.04, 82.08, 82.12, and 82.14 of the Revised Code of Washington) on the value of the services and materials provided in conjunction with implementation of the recommended project.

d. The Board's recommendations are made with the provision that, prior to implementation, non-Federal interests will agree to comply with the following requirements:

(1) Be responsible for conveying to the United States, prior to the time needed and without cost, all lands, easements, and rights-of-way for the single or staged retention structure and be responsible for providing without cost to the United States all lands, easements, and rights-of-way required for dredging and downstream actions, including borrow areas and dredged material disposal areas for excavated material including necessary retaining works, as determined necessary by the Chief of Engineers, for project construction and subsequent maintenance;

(2) Accomplish without cost to the United States all alterations and relocations of buildings, roads, bridges, and other structures or utilities made necessary by implementation of the project;

(3) If any of the above requirements cannot be provided in a timely manner, provide a cash contribution to the United States, prior to the time needed in an amount which the Chief of Engineers determines to be necessary to allow acquisition of needed property and for accomplishment of needed relocations or alterations by the United States. A final contribution adjustment to be made after actual costs are determined;

(4) Hold and save the United States free from damages due to implementation of the plan, not including damages due to the fault or negligence of the United States or its contractors;

(5) Operate and maintain any federally undertaken mitigation project which is determined to be justified, such as the operation and maintenance of fisheries facilities for a single retention structure; and

(6) Maintain all dredged material disposal sites.

18. The recommendations contained herein reflect information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

FOR THE BOARD:

N. G. DELBRIDGE, JR.
Major General, USA
Chairman

Photograph 1. Mount St. Helens, 18 May 1980
(U.S. Geological Survey)

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CHAPTER I - BACKGROUND

AUTHORITY

The eruption of Mount St. Helens, which began in the spring of 1980, resulted in the movement of sediment creating a threat of flooding and navigation disruption in southwestern Washington. President Reagan recognized that the Federal Government was spending millions of dollars for emergency action and would continue responding to any emergency which threatened life and property. Thus he requested, through a Memorandum to the Secretary of Defense, that the Corps of Engineers prepare alternative strategies for handling the projected movement of sediment. The strategies were to address the continuing problems of flood hazards and potential disruptions to navigation based upon engineering feasibility, economic merit and environmental sensitivity.

The report, "A Comprehensive Plan for Responding to the Long-term Threat Created by the Eruption of Mount St. Helens, Washington," was forwarded to the President in November 1983. The plan evaluated five alternative strategies for sediment control and analyzed six alternative outlets for stabilizing the level of Spirit Lake. In transmitting the Comprehensive Plan report, the Assistant Secretary of the Army recommended finding a permanent solution to the sediment control problem that could be forwarded for congressional authorization and funding. This report responds to that recommendation. Key elements of the Comprehensive Plan are summarized later in this document. Further refinement of the plan presented in this report will occur during the Continued Planning and Engineering (CP&E). In addition, analysis and design of other alternatives will continue.

STUDY AREA

The study area encompasses 1,200 square miles (sq. mi.) in southwest Washington, reaching north from the Columbia River to the headwaters of the Toutle River at Mount St. Helens. A vicinity map and a more detailed map of the study area are shown in figures I-1 and I-2, respectively.

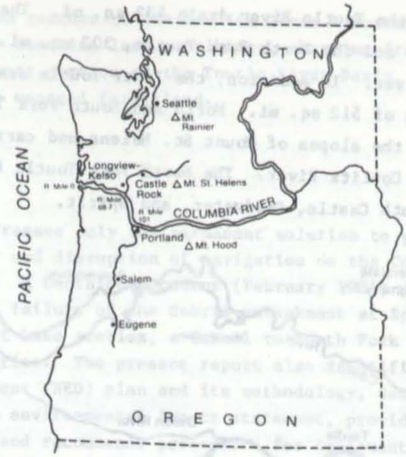


Figure I-1. Vicinity Map

The Columbia River flows east to west through a broad trough between the Cascade and Coast mountain ranges. It provides the navigation channel for vessels enroute from the Pacific Ocean to the deep-draft Ports of Vancouver, Washington, and Portland, Oregon. The reach affected by sediment accumulation lies between river miles (RM) 60 and 72. Lands along both shores, Oregon on the south, Washington on the north, consist of a narrow valley bottom adjacent to low hills. Several small, low-lying islands are located in the river through this reach.

The Cowlitz River and its principal tributary, the Toutle, are typical of rivers draining the west slopes of the Cascade Range. The terrain is mountainous and, except for clearcuts and areas devastated by the 1980 eruption, heavily forested.

The Cowlitz River drains an area of 2,840 sq. mi., including the Toutle River drainage area. Below its confluence with the Toutle, the lower 20 miles of the Cowlitz passes by the towns of Castle Rock, Lexington, Kelso, and Longview, Washington, before entering the Columbia River at RM 68.7.

The major tributaries of the Toutle River drain 432 sq. mi. The South Fork Toutle drains 129 sq. mi. and the North Fork Toutle, 303 sq. mi., including 131 sq. mi. from the Green River. In addition, the lower Toutle drains 80 sq. mi. for a total drainage area of 512 sq. mi. North and South Fork Toutle Rivers have their headwaters on the slopes of Mount St. Helens and carry runoff and sediment westward to the Cowlitz River. The North Fork Toutle River Basin includes three lakes, South Castle, Coldwater, and Spirit.

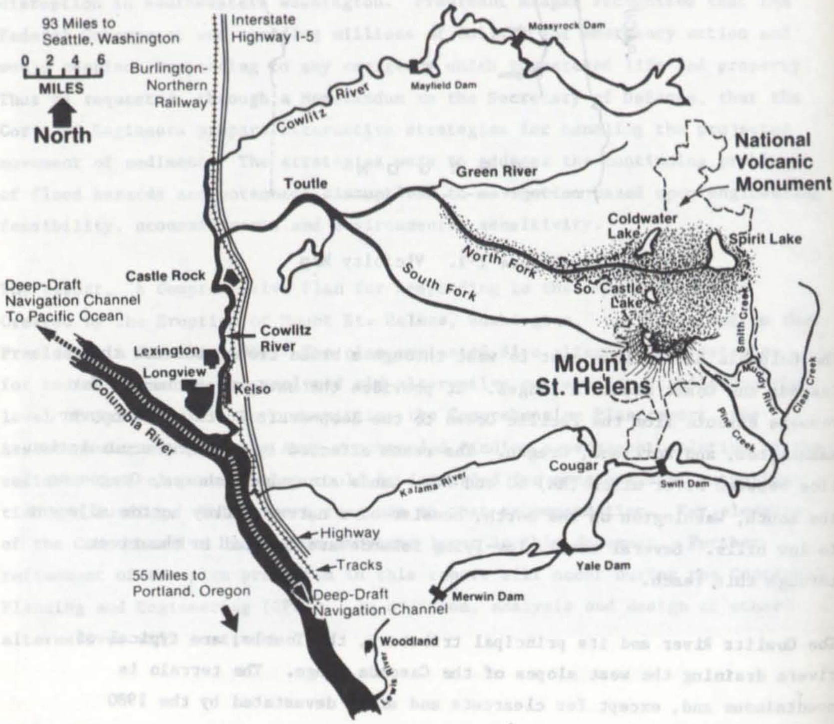


Figure I-2. Study Area for Feasibility Study

The area affected by potential flooding varies from bottom land along the Cowlitz to uplands at the base of the mountains of the Cascade Range. Industrial riverfront and urbanized property lie adjacent to both the Columbia River

and the downstream reaches of the Cowlitz River. Further up the Cowlitz, adjacent property contains less population, changing from urban to agricultural land use. The upper portion of the Toutle River Basin, except the volcanic and mudflow areas, is managed forestland.

STUDY SCOPE

This analysis addresses only the permanent solution to potential flooding on the Cowlitz River and disruption of navigation on the Columbia River caused by sediment buildup. A Decision Document (February 1984) dealt with the potential flooding due to a failure of the debris embankment at Spirit Lake. The solution to the Spirit Lake problem, a tunnel to North Fork Toutle River, currently is under construction. The present report also identifies the National Economic Development (NED) plan and its methodology, describes the preferred plan, includes an environmental impact statement, provides a possible cost-sharing formula, and recommends procedur‹s for implementing the long-term solution to the sediment problem.

This report utilizes the formulation process developed in the Comprehensive Plan (see appendix A). It also contains the sensitivity analysis presented in the Plan (see appendix B) which shows the single retention structure as the least costly solution to the sediment problem. The revised sediment projections discussed in this report fall partly within and partly below the ranges of total sediment volume and annual sediment rates presented in Comprehensive Plan. This is due to our findings of reduced observed erosion. In the Comprehensive Plan, a total sediment range of 400 mcy to 2 bcy was discussed; in the Feasibility Report a range of 325 mcy to 975 is discussed. In the Comprehensive Plan, an annual range of 30 mcy to 70 mcy was discussed; in the Feasibility Report, various ranges were discussed and an initial annual rate of 28 mcy was chosen. A discussion of the impacts of the new sediment budget on the sensitivity analysis contained in the Comprehensive Plan follows in Chapter II.

In developing a permanent solution to the sediment problem, it became necessary to incorporate new information developed since completion of the Comprehensive Plan. These new data revised the projections on sediment movement and deposition. The major problems remain the increase in potential flooding to communities along the Cowlitz River, potential impacts due to interruption of the transportation corridor crossing the Toutle River, and potential disruption of navigation on the Columbia River.

This report also describes a base condition, which incorporates the interim Cowlitz dredging authorized by Public Law (PL) 98-63 (the Supplemental Appropriations Act of 1983), and analyzes its benefits and costs as a part of the economic study necessary to develop the NED plan. These changes will cover only additional data on sediment delivery, future studies of whether construction should occur in stages and comparative analysis of risks, benefits and costs; the overall plan is not expected to change during CP&E. This study has been conducted in compliance with the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.

To further define the problems, investigation focused on updating Comprehensive Plan estimates for the amount and rate of sediment expected to erode and move through the system over a 50-year period. Study of the lower 20 miles of the Cowlitz River concentrated on the danger of flooding from continued sediment accumulation. In addition to damaging private, State, and industrial property, flooding could disrupt highway traffic on Interstate 5 (I-5) and rail traffic on the Burlington-Northern Railway line. Thus, the study of the lower Cowlitz assessed water elevations and economic loss from flooding and established impacts of proposed alternative measures to reduce those losses. Social and environmental effects of the alternative measures were also given careful consideration. The portion of the study dealing with the Columbia River, downstream from the mouth of the Cowlitz, focused on the effects of these alternative measures on navigation channel maintenance and on impacts to fish and wildlife for all affected areas.

STUDY LIMITATIONS

Overall, the study observed the limits defined in the Comprehensive Plan. First, it assumed that pre-eruption conditions were unlikely to be restored within the 50-year project life. Rather, alternatives were measured against the most probable future conditions.

Second, it assumed that another eruption of the magnitude and devastation of 18 May 1980 will not occur. This assumption was necessary, for a major eruption would necessitate a new study of the drastically changed conditions. Comprehensive studies of Mount St. Helens and other volcanic eruptions, both recent and in the geologic past, have established trends useful for predicting future eruptions and volcanic hazards. For example, based on the eruptive history of Mount St. Helens. Crandell and Mullineaux (1978) assessed Mount St. Helens as having a high probability of erupting within this century. Once a major volcanic sequence has been initiated, the sequence can last for several decades. Volcanic eruptions tend to be most frequent, volatile, and potentially dangerous during the initial phases of the volcanic sequences. The 1980 eruption diminished the chance of any future devastating debris avalanche into the North Fork Toutle River because a large portion of the mountain no longer exists. Thus, planning proceeded based on an assumption of no reoccurrence of a large event like that of 18 May 1980. However, because of the great uncertainties associated with future volcanic activity as well as potential mudflows, the study tests the preferred plan against the eventuality of such events to assure that the plan would not increase the hazards to downstream communities.

Traditional approaches used to forecast sediment movement had to be modified. Models used to simulate a river system's behavior over time would simply not accommodate studying the amount of sediment moving through the system or the changes in river hydraulics it produces. With these constraints on methodology and data, the study limited computer modeling of the river system to the lower 20 miles of the Cowlitz River and to the Columbia River at the mouth of the Cowlitz, where the effects of sediment deposition remain most critical.

Initially, the study assumed that the without-project condition would be defined as no-action. With passage of PL 98-63 on 30 July 1983, which authorized interim flood protection for developed portions of the Cowlitz River flood plain, a no-action condition became unrealistic.

SUMMARY OF COMPREHENSIVE PLAN

This section summarizes the Comprehensive Plan which included a sensitivity analysis of the final alternative measures relative to different sediment rates and total quantities. It describes the emergency action accomplishments, the original problem statement, and alternative management strategies for dealing with the problems of sedimentation and Spirit Lake. This material provides the background for understanding the revised problem statement necessitated by the new sediment estimates and its effect on the sensitivity study presented in the Comprehensive Plan. Locations and sites associated with previous actions are indicated on figure I-3.

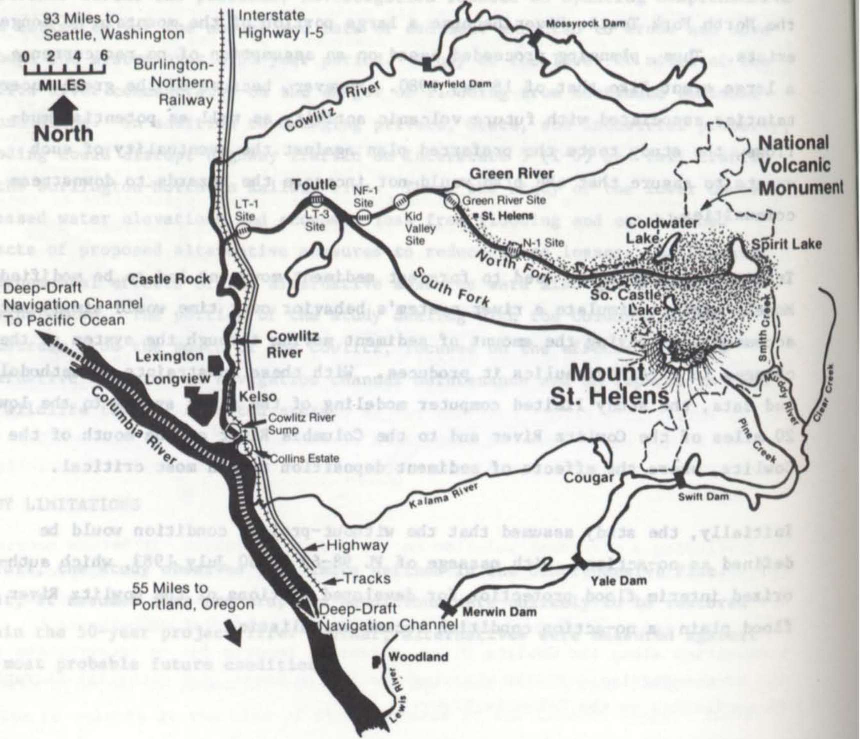
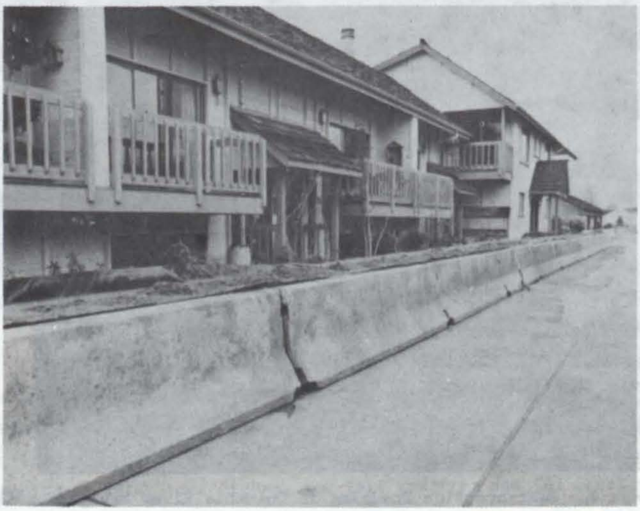


Figure I-3. Study Site Locations

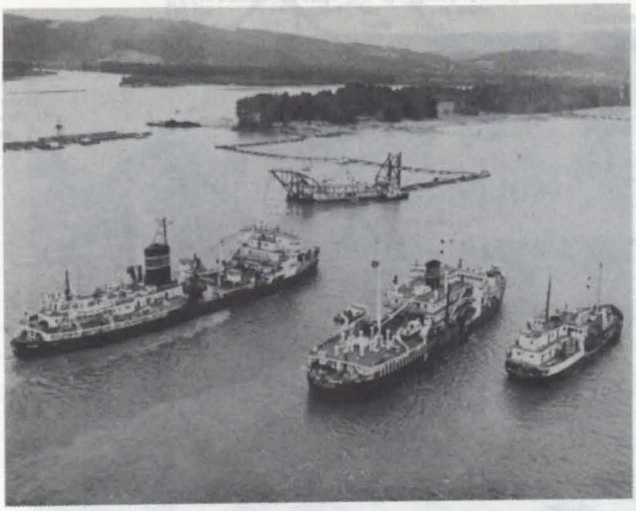
Accomplishments Under Emergency Actions

Immediately after the 18 May 1980 eruption, the Corps of Engineers initiated emergency actions under PL 84-99 to reduce the flood potential at communities along the Cowlitz River and to restore the Columbia River navigation channel. From that time to the present, the Corps and other Federal, State, and local agencies have been intensively involved in emergency activities on the Toutle and Cowlitz Rivers to insure the safety of communities and the 50,000 people located along the Cowlitz. Through fiscal year 1983, Mount St. Helens related emergency activities by the Corps total $327 million, demonstrating the Federal Government's commitment to minimizing damage and property losses in those areas adversely affected by the extraordinary conditions created by the eruption. These emergency activities included improvements and temporary raises to levees, purchase of flood control storage from Tacoma City Light Company, construction of two debris retaining structures in the Toutle River Basin, excavation of sediment stabilization basins in the lower Toutle River, dredging the Columbia River construction of control outlets at Coldwater and South Castle Lakes, and emergency pumping at Spirit Lake.



Photograph 2. Temporary Levee Along Cowlitz River

Photograph 3. Dredging at a Sediment Stabilization Basin



Photograph 4. Post-eruption Dredging in Columbia River Navigation Channel

Problem Statement (Comprehensive Plan)

The 18 May 1980 eruption of Mount St. Helens created a massive landslide which deposited more than 3 billion cubic yards (bcy) of material in the upper Toutle River Basin. This avalanche, covering 32 square miles up to 600 feet deep, is composed mainly of basalt and dacite material from the north side of Mount St. Helens, overlain by blast material and volcanic ash. During the eruption, the avalanche blocked some tributary streams, creating new lakes with unstable volcanic debris embankments in addition to blocking outlets to existing lakes.

Photograph 5. Mount St. Helens and Spirit Lake after 1980 Eruption

The Comprehensive Plan suggested that without preventive measures the following events would likely occur: (a) sedimentation in the Cowlitz River, causing flooding; (b) sedimentation in the Columbia River, interrupting navigation; (c) disruption of interstate highway and rail traffic; and (d) breakout of Spirit Lake, causing catastrophic flooding.

Flood Control and Navigation. Studies indicated that starting in 1980 an estimated 1 bcy of material would erode from the avalanche by the year 2030. Of this 1 bcy, approximately 50 million cubic yards (mcy) of sand, silt, and gravel would erode each year from 7 to 10 years, assuming average water year donations, with 30 mcy moving into the Cowlitz River system annually. Erosion of the avalanche was projected to decline annually after 1990. Without preventive action, this material passing through and depositing in the Toutle, Cowlitz, and Columbia Rivers would reduce the hydraulic, or flood-carrying capacity of the Cowlitz River channel. This in turn, would cause severe flood damages to the Cowlitz River communities and greatly increase annual dredging costs in the Columbia River. The lower Cowlitz channel would be filled with sediment by 1987; existing levees would no longer function effectively. The towns of Kelso, Longview, Lexington, and Castle Rock would be devastated by the resulting floods. The studies estimated damages by flooding to Castle Rock, Lexington, Kelso, and Longview would total $1.9 billion (1982 dollars) for the period 1983 to 1987, including damage to such major transportation arteries as I-5 and Burlington-Northern Railway bridges. Federally subsidized flood insurance coverage could total $900 million. While not anticipating a new eruption of the 1980 magnitude, studies indicated that minor volcanic activity, mudflows, a series of storms or rapid snowmelt would continue jeopardizing the lives and property of the people in the flood plain.

By the year 2030, the Cowlitz-Toutle system would deposit an estimated 319 mcy of sand in the Columbia River. That amounted to two times the 154 mcy needing excavation from the Columbia River during the same period assuming average years. Prior to the eruption, navigation maintenance costs averaged $4.4 million per year. If no action were taken to control the movement of Cowlitz-Toutle sediment, navigation maintenance costs could increase to about $25 million annually.

Spirit Lake. In addition to the damages caused by continued sediment flow from the debris avalanche, potentially disastrous floods would result if the embankment impounding Spirit Lake failed. Worst-case studies completed by the U.S. Geological Survey (USGS) indicated that a failure of this embankment would create a mudflow totally destroying development in the Cowlitz Valley. With an estimated peak flow of 2.6 million cubic feet per second (cfs), mudflow depths

could reach 60 feet in the upper reaches of the Cowlitz River at Castle Rock and 40 feet in the lower reaches at Longview-Kelso. Studies estimated peak flows entering the Columbia River at 1 million cfs.

Initially following the eruption, Spirit Lake had an elevation of approximately 3,462 feet with an impounded water volume of 278,000 acre-feet. Barge-mounted pumps operated from 5 November 1982 to 31 July 1983, pumping water from Spirit Lake to the North Fork Toutle River. Pumping resumed on 22 September 1983 and continued through July 1984. Pumping again resumed on 2 October 1984. Without pumping or failure of the debris embankment, the blockage would overtop in late fall or early winter 1985-86. Estimated damages could reach $2.5 billion.

Alternative Management Strategies (Comprehensive Plan)

The Comprehensive Plan used two separate, but related, planning processes to determine alternative management strategies for addressing the problems of sedimentation downstream of Spirit Lake and maintenance of a safe water level at Spirit Lake.

Sedimentation. The urgent need to protect communities along the Cowlitz River and the inherent uncertainties associated with sediment predictions required a flexible and rapidly implementable solution. Such a solution would also resolve the deep-draft navigation channel problems in the Columbia River caused by the sediment flow. Experience in emergency actions since the eruption contributed to the selection and analysis of potential solutions. The Comprehensive Plan analyzed 13 measures in formulating a plan to prevent flood damages on the Cowlitz River and to reduce maintenance dredging costs on the Columbia River.

Criteria used in screening the various alternatives focused on the effectiveness of each in accomplishing the following major objectives: reducing flood damages; reducing navigation maintenance costs; minimizing impacts on fish and wildlife; and providing flexibility to allow for uncertainties in sediment movement prediction. The preliminary screening produced five alternative management strategies which warranted more detailed study. The following

paragraphs briefly describe these strategies, with appendix A containing a more thorough discussion of them.

Limited Permanent Evacuation. As the Cowlitz River filled with sediment. threatened areas upstream of Kelso and Longview, including the communities of Castle Rock and Lexington, would be evacuated and allowed to flood. Levees near Longview and Kelso would be raised, as would major highway and railway bridges. Dredging requirements in the Columbia River to maintain deep-draft navigation would increase sixfold in cost to $25 million annually.

Sediment Stabilization Basins. Basins (sumps excavated in the riverbed) would be located at three sites in the Toutle and North Fork Toutle Rivers; annual dredging and off-site disposal would be required, both at the basins and downstream in the Columbia River.

Multiple Retention Structures with Dredging. Four earth- and rock-fill structures would be constructed concurrently across the main stem and North Fork Toutle Rivers. The retention structures would be about 40 feet high, and would trap most sediment except during high flows when material would pass over the structures. Dredging and extensive off-site disposal would be required, both at the structures and downstream in the Columbia River.

Multiple Retention Structures without Dredging. Structures 160 to 190 feet high would be located at three sites on the Toutle River. The first structure would be built downstream and the others added upstream as needed; the sediment trapped would not be removed. Dredging on the Cowlitz and Columbia would still be necessary to cope with material already in the system below the structures.

Single Retention Structure. A single, roller-compacted concrete, gravity dam 250 feet high would be constructed across the Toutle River at one of three sites. The structure would prevent sediment from passing in all but extreme flood conditions. It would rise in stages to the maximum of 250 feet; trapped sediment would not be removed. Some additional measures such as dredging would be required to keep material already in the river system below the structure from reaching the Cowlitz and Columbia Rivers.

Total Costs of Alternative Management Strategies

The total costs of the alternatives and the net present value of those costs which would have accrued over the life of the project are shown in the following table.

Table I-1
Total Costs of Alternative Management Strategies
($ millions)

Management Strategies	Total Cost	Present Value of Total Costs	Present Value of Average Annual Costs	Benefit-to-Cost Ratio[1]
1. Limited Permanent Evacuation	$1,048.1	$612.7	$49.4	2.68
2. Sediment Stabilization Basins	751.0	398.1	32.1	4.12
3. Multiple Retention Structures with Dredging	1,153.3	685.6	55.2	2.40
4. Multiple Retention Structures without Dredging	536.6	340.8	27.5	4.81
5. Single Retention Structure[2]	341.7	243.1	19.6	6.75

1. All plans provide cumulative average benefits of $132,300,000.
2. Used Green River site costs.

Sensitivity Analysis of Alternate Management Strategies

The Comprehensive Plan developed a sensitivity analysis which included changes in both total sediment volume eroded and initial annual sediment delivery for all five management strategies. The sensitivity analysis indicated the impact of variations from the anticipated 1 bcy total sediment erosion and initial annual erosion of 50 mcy. Total erosion varied from as little as 400 mcy to a high of 2 bcy. Initial annual erosion ranged from 30 mcy to 70 mcy. The analysis measured in dollars the sensitivity of the management strategies to these variations (see appendix B).

Each of the five management strategies possessed flexibility to respond to changes in total sediment yield. Strategies 1, 2, and 3, which involved the dredging and disposal of sediment, proved the most sensitive and varied the most in cost. Strategies 4 and 5 were more stable because those structural solutions did not require sediment handling. Ranges in cost for the five strategies and the three total sediment yields are shown in table I-2. A drastic reduction in the total sediment yield, from 1 bcy to 400 mcy would result in strategy 2 being less expensive than strategy 5.

Table I-2
Alternative Management Strategies Cost Comparison
Total Sediment Yield

Management Strategy	Total Sediment Yield (Cost $000) 400 mcy	1 bcy	2 bcy
1	$527	$1,048	$2,500+
2	218	751	2,000+
3	346	1,153	2,500+
4	311	537	670
5	275	342	442

The management strategies were relatively insensitive to changes in annual sediment delivery. Within the range of 30 mcy to 70 mcy annual erosion, the five strategies did not change in their relative ranking. Strategy 5 proved far less expensive than any other strategy, as shown in table I-3.

Table I-3
Alternative Management Strategies Cost Comparison
Annual Sediment Yield

Management Strategy	Annual Sediment Deliveries (Cost $000) 30 mcy	50 mcy	70 mcy
1	$1,048	$1,048	$1,048
2	706	751	898
3	1,166	1,153	1,151
4	490	537	557
5	331	342	367

In summary. strategy 5 (single retention structure) was the most cost effective of the strategies, except in the extreme reduction of total sediment erosion. In that situation, strategy 2 (sediment retention basins) was somewhat lower in cost.

The sensitivity analysis results indicate that costs of management strategies are relatively immune to variations in initial rates of erosion between 30 and 70 mcy/year. Additionally, the analysis shows that costs of strategies concentrating on dredging for sediment removal are sensitive to total sediment volumes, while costs of strategies focusing on structural blockage of sediments are relatively insensitive to total sediment volumes.

These sensitivities result from the fact that the Cowlitz and Toutle basins are narrow valleys with large disposal sites at a premium. Once the inexpensive disposal sites are used up, as now occurring, dredging costs rise greatly with the additional hauling needed to reach more distant sites. The efficiency of the structural strategies not needing large dredging efforts varies less over a wide range of total sediment delivery.

Spirit Lake

A Decision Document, prepared in February 1984, evaluated the six alternatives to solve the Spirit Lake problem and included concerns from agency and public involvement.

The elevation of 3,440 feet NGVD was verified as the best level to lower Spirit Lake, considering debris embankment stability and visual esthetics. The Decision Document eliminated open channel and permanent pumping alternatives because of potential risk and safety problems and lack of agency and public support. Although tunnel alinement B_1 was rated high in safety, constructability and public support, the interbasin transfer of water and potential water quality impacts made this alternative unacceptable to the Governor of Washington and various agencies. The remaining three alternatives - buried conduit, and tunnel alinements F and G - were then compared and alinement F recommended. Tunnel alinement F is now under construction with drawdown scheduled to begin about 1 April 1985.

CHAPTER II - UPDATED PLANNING CONSIDERATIONS

GENERAL

Following completion of the Comprehensive Plan, the U.S. Geological Survey (USGS) and other sources supplied additional data which necessitated a reevaluation of the sediment analysis. The Comprehensive Plan problem statement discussed in the previous section was the direct consequence of the projected sediment budget. Major revisions to the sediment budget necessitated reanalysis of the problem statement. This section presents the changes to the sediment budget, revises the problem statement based on those revisions, compares the changes with the Comprehensive Plan sediment budget, describes a base condition from which all alternatives are measured, and estimates impacts on the sensitivities given in the Comprehensive Plan.

The problem statement contained in the Comprehensive Plan is based on a no-action condition which is not considered realistic. This section defines a base condition which reflects the Federal Government's commitment to providing protection for communities on the Cowlitz River, including activities already undertaken as a result of PL 98-63. However, actions associated with the base condition must themselves be justified against the no-action condition. Therefore, the following discussion of the no-action condition is to serve only as an economic comparison for the base condition actions.

The uncertainties associated with the sediment budget developed for this report, as well as that for the Comprehensive Plan, have been dealt with by performing sensitivity analyses on proposed management alternatives. Monitoring and refinement will continue during the design phase to incorporate the most up-to-date sediment information available. The sediment budget used in this report is based on observed erosion and sediment movement from the debris avalanche in the Toutle-Cowlitz system during the past four years. Data available included Cowlitz/Toutle suspended sediment data through September 30, 1983, Cowlitz/Toutle River cross sections through April 1984, U.S.G.S. debris avalanche cross sections through early 1984 and debris avalanche backhoe soil samples from May 1984. Projections for future erosion and sedimentation are based on these observations and the average hydrology of the past 50 years. The largest storm during the past 4 years had approximately a 10-year occurrence frequency. While there has been no extreme post-eruption storm event, Spirit Lake has experienced several intense rain storms. Monthly rainfall in November 1983 was 229% of normal including an intense 3.33 inches on one day. It is expected that large quantities of material will erode with

extreme events (100-year and above) or as a result of volcanic or hydrologic events. Although no historical basis exists for raising the current sediment budget, sediment ranges on the high side have been considered in evaluating alternatives to cope with future special events.

The monitoring and refinement is essential since consultants and some scientists in the field, who have had the opportunity to briefly review the sediment analysis, are concerned that estimates presented may be low both in total volume and rate of delivery because they are based on average hydrology. These concerns reflect the uncertainties of sediment forecast for volcanic and hydrologic events and the fact that infrequent storms or mudflows could produce sediment deliveries in excess of the forecasted amounts.

Photograph 6. The Debris Avalanche with N-1 Retention Structure at the Toe (Jan Fardell)

REEVALUATION OF SEDIMENT BUDGET

Background

The sediment budget presented in the Comprehensive Plan contained the best available sediment transport measurements and cross-sections of the avalanche. Sediment transport measurements supplied the data to develop an estimate of sediment yields to the Cowlitz River. The cross-sections were used to develop the eventual equilibrium profile and channel geometry in the avalanche and to estimate total and annual sediment yields. Scour, deposition and yield patterns in the Toutle/Cowlitz River system were then computed from the debris avalanche to the Columbia River.

The principal conclusions of the Comprehensive Plan analysis included:

a. The sediment erosion from the avalanche would average 50 mcy per year for the initial 7 to 10 years, and would total 1 bcy during the 50-year project life.

b. The Toutle River system was a depositional area for sediments.

c. For no-action conditions, maximum accumulative deposition of 50 mcy in Cowlitz River would be reached in 1987 and 240 mcy would have to be dredged from Columbia River between 1981-2012 to maintain the navigation channel.

During the preparation of that sediment budget, the study team recognized that the data were limited, that some assumptions would have to be checked, and that the sediment budget needed review whenever additional data became available.

In October 1983 the Portland District began receiving updated data. The USGS provided tabulation of the total sediment transport for water years (WY) 1981 and 1982 at Kid Valley on the North Fork Toutle River, at Tower Road on the main stem Toutle River, and at Castle Rock on Cowlitz River. Total sediment data from these stations for WY 1983 arrived in February and March 1984.

Updated USGS cross sections of the avalanche and the Toutle River system taken repeatedly from 1980 to 1983, became available in late 1983 and early 1984.

Results from an Oregon State University (OSU) study of the debris avalanche, including cross sections, sediment yields, geomorphic processes, and drainage and channel development, were periodically received from late 1983 to early 1984. OSU's final report was received in June 1984.

The compilation, comparison, analysis and interpretive results of the recently received data are discussed and documented in appendix C, Sedimentation Study for Feasibility Report.

Objectives

The objective of a sediment analysis is to predict changes to water surface profiles resulting from future sediment deposition in the Cowlitz River and to predict future sediment deposition which could interrupt navigation in the Columbia River. Estimates of sediment deposition provide a basis for planning sediment control measures. The sediment budget focuses on the composition and rate of sediment movement through the Toutle/Cowlitz/Columbia River system.

FORECAST OF FUTURE SEDIMENT MOVEMENT

To develop a long-term sediment/flood control and navigation plan for the Toutle/Cowlitz/Columbia system requires predicting future sediment yields and identifying the sources of those sediments. Critical elements contributing to a sediment budget are identified below and addressed in more detail in appendix C.

Elements of Forecast

Debris Avalanche Deposits. The forecast estimates total volcanic deposits, their composition, volume, slope stability, and distribution.

Avalanche Erosion Processes and Trends. The forecast predicts drainage network development on the avalanche, stream channel incision and widening, effects of a rising water table, and processes contributing to sediment loading of streams.

Toutle River. The forecast analyzes scour and depositional patterns, potential for bank erosion, and sediment movement through North Fork and main stem Toutle River.

Cowlitz River. The forecast studies the scour and depositional patterns in the Cowlitz River that occurred during WY 1982 and 1983. That analysis included the effects of dredging, changes in bed material, and grain sizes transported and/or deposited; an estimate of future sediment movements (as determined by HEC-6 modeling with input from hydrographic survey), sediment sampling and hydrologic records; and forecasting future flood elevations from the estimate of sediment depositions over time and place.

Columbia River. The forecast uses HEC-6 modeling to determine the depositional pattern in the Columbia River navigation channel and provides an estimate of future deposition.

The following summary discusses a forecast of erosion, transport, and deposition for each of the streams mentioned above. These forecasts are based on the data and analysis presented in appendix C and represent the best current estimates. The actual volumes of sediment eroded, transported, and deposited in any single year will range above or below those shown, but the long-term averages should reflect forecasted trends. As new information becomes available and knowledge of the complex processes occurring in the system grows, these estimates will improve.

Debris Avalanche

Sediment yields from the debris avalanche are expected to remain high throughout the 50-year project life. Ongoing changes occurring in the avalanche will gradually reduce the rate of erosion, but based on yields from other watersheds presented by Brown and Ritter (1971), the Toutle River Basin is expected to remain the most rapidly eroding watershed of its size in the United States.

Base Level Sediment Yields. Base level sediment yields are those expected from the debris avalanche as a result of normal hydrologic sediment erosion processes. Estimated base yields are determined by the initial yield and expected changes on the debris avalanche.

Forecasted Sediment Yields. Under conditions existing during the past three years, and projected to continue for several more, a number of non-base level events have happened. The most significant of these events include mudflows, lake breakouts, and major changes in channel alinement. Because the base level yields did not contain any allowance for these events, these levels are too low for use in defining the problem statement.

A forecasted sediment yield curve was prepared by incorporating the base curve and the non-hydrologic (mudflow) sediment producing events. The initial yield for this curve is 28 mcy per year (figure II-1). This curve allows for the occurrence of mudflows, channel re-alinements, and above normal peak storm discharges. These are discussed in more detail in appendix C.

Yields from Infrequent Events. The sediment entering the Toutle-Cowlitz River system is delivered episodically, for the most part during winter storms. Just how much sediment is transported is dependent on the intensity, duration, and timing of these storms. The timing of these yields cannot be determined precisely because of the infrequent nature of events such as mudflows or storms.

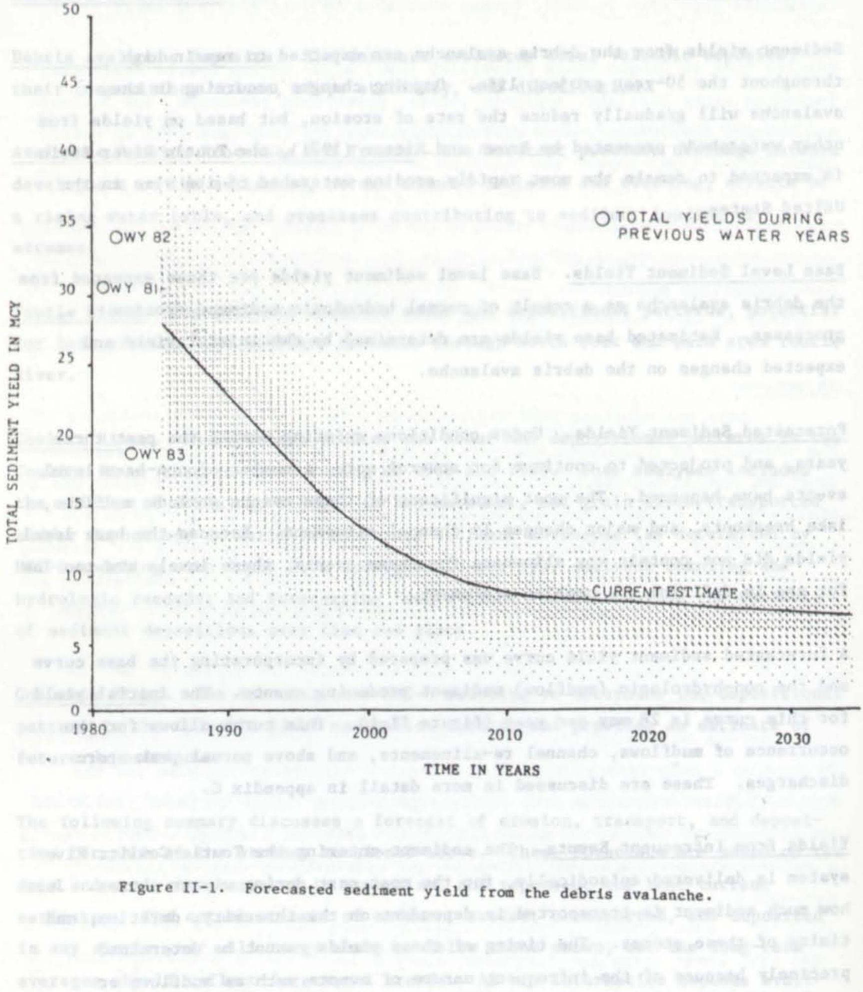


Figure II-1. Forecasted sediment yield from the debris avalanche.

Sediment transport varies as an exponential factor of water discharges. Thus, high streamflows during major storms carry many times the amount of sediment transported by smaller flows. In the Pacific Northwest, these storms often occur in series: two storms can occur within two or three weeks, each transporting a large quantity of sediment. In such cases the lower Cowlitz River would not be able to transport all the sediment delivered by the first storm through the system before the second storm yielded an additional load of sediment. A series of storms in 1982, for example, delivered an estimated 12 mcy of sediment to the lower Cowlitz within 4 weeks; the total yield to the Cowlitz for that year was an estimated 34 mcy.

Another unpredictable variable is the occurrence of mudflows. Mudflows--flow carrying as much as 60 to 80 percent solid material--are potentially major contributors to sedimentation problems in the Toutle/Cowlitz/Columbia River system. In just a few hours they can deposit millions of cubic yards of sediment in river channels. These mudflows can be generated by heavy rainfall on the debris avalanche. When groundwater levels are high, saturated channel banks slump into the flow. In addition, mudflows can also be triggered by minor volcanic eruptions. On 19 March 1982, a relatively small eruption occurred while a snowpack existed in the crater. Part of the blast was directed against the crater wall, rapidly melting ice and snow. The resulting mudflow, moving about 30 feet per second in the headwaters region of the North Fork Toutle, eroded 14 mcy of sediment from the debris avalanche. All but 4 mcy of this mudflow redeposited above debris retention structure (DRS) N-1. Current estimates indicate that Mount St. Helens will continue erupting, though these eruptions will not be as dramatic as the 18 May 1980 event. However, minor events like the 19 March 1982 eruption are expected to occur frequently.

A design mudflow, which is used in later risks analysis, is developed and described in appendix D. The design mudflow is considered an infrequent event, with an approximate recurrence interval of 100 to 200 years, and is estimated to contain 75 mcy of sediment.

Projected Erosion

North Fork and Main Stem Toutle Rivers. Approximately 20 mcy of the 92 mcy yards of sediment delivered to the Cowlitz River in water years 1981-83 eroded downstream of the debris avalanche. Study results showed the existence of a large source of sediment but also indicated that almost all of the erosion on the Toutle River occurred within the 1980 mudflow deposits. An older lahar or mudflow, the Pine Creek lahar that underlies and bounds the 1980 mudflow, was coarser in size and less susceptible to erosion and transport. The study also estimated the material volume of the 1980 mudflow deposit at 20 mcy in the channel and floodplain of the Toutle and North Fork Toutle River. The projected rate of erosion based upon observed sediment transport, channel hydraulics, and theoretical development of landscapes, suggested a sediment yield beginning at 5 mcy/year and declining to less than 0.5 mcy/year in 10 years.

Cowlitz River. The volume of fine sand and coarser material delivered to the Toutle River governs sediment deposition in the Cowlitz River. However, based on the results of sediment transport modeling for the no-action condition, the initial volume of deposition is assumed equal to 35 percent of all sand delivered by the Toutle River. The best estimate of avalanche yields combined with Toutle River erosion gives the projected sand yield to the Cowlitz (figure II-2). This results in an estimate of a maximum 78 mcy of deposition in the Cowlitz River, if no aciton is taken to reduce sediment accumulaton.

Columbia River. Winter sand discharge from the Cowlitz River could deposit in the Columbia River and interfere with shipping in the vicinity of the Cowlitz/Columbia confluence for the entire 50-year project life. Figure II-3 shows the forecast deposition based on projected Cowlitz River sand discharges. Assuming near-average runoff, the problem will be most severe during the first 7 to 10 years, when predicted erosion rates on the avalanche and Toutle River are highest. Deposition in the Columbia River should only be a problem during the winter, when Columbia River flows are low and storms in the Toutle River Basin produce large volumes of sediment.

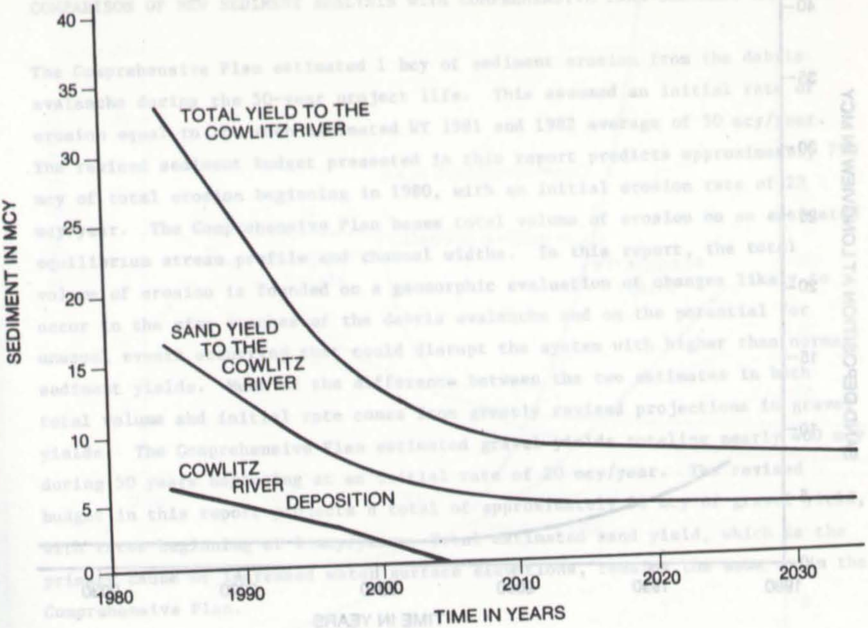


Figure II-2. Cowlitz River annual yields.

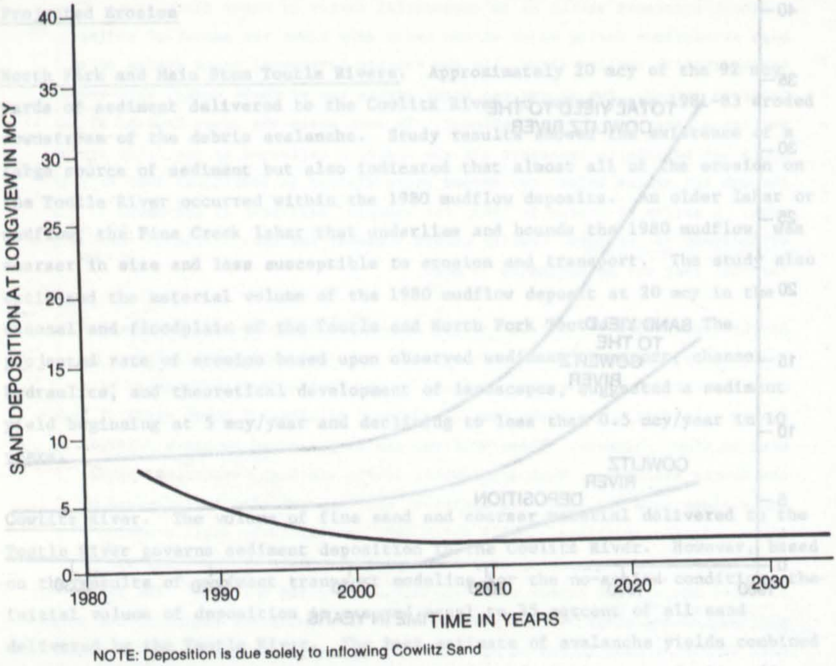


Figure II-3. Forcasted Columbia River Sand Deposition at Longview Under No-Action.

COMPARISON OF NEW SEDIMENT ANALYSIS WITH COMPREHENSIVE PLAN SEDIMENT ANALYSIS

The Comprehensive Plan estimated 1 bcy of sediment erosion from the debris avalanche during the 50-year project life. This assumed an initial rate of erosion equal to the then-estimated WY 1981 and 1982 average of 50 mcy/year. The revised sediment budget presented in this report predicts approximately 750 mcy of total erosion beginning in 1980, with an initial erosion rate of 28 mcy/year. The Comprehensive Plan bases total volume of erosion on an estimated equilibrium stream profile and channel widths. In this report, the total volume of erosion is founded on a geomorphic evaluation of changes likely to occur in the nine reaches of the debris avalanche and on the potential for unusual events occurring that could disrupt the system with higher than normal sediment yields. Much of the difference between the two estimates in both total volume and initial rate comes from greatly revised projections in gravel yields. The Comprehensive Plan estimated gravel yields totaling nearly 400 mcy during 50 years beginning at an initial rate of 20 mcy/year. The revised budget in this report projects a total of approximately 50 mcy of gravel yield, with rates beginning at 1 mcy/year. Total estimated sand yield, which is the primary cause of increased water surface elevations, remains the same as in the Comprehensive Plan.

The rate of decay and levels to which yields will decline also differ between the Comprehensive Plan and the best estimate presented in this report. The difference is shown on figure II-4. The higher yields currently projected for the end of the 50-year period result primarily from sediment sources immediately downslope of Mount St. Helens.

Another difference between the Comprehensive Plan and this report is the behavior of the North Fork and main stem Toutle Rivers. In the Comprehensive Plan, they are classified as areas of sediment deposition but updated studies indicate they really may be areas of sediment erosion. That change in classification accounts for the earlier decline in sand yields to the Cowlitz River, shown in the Comprehensive Plan, as material would not be stored for later erosion (figure II-5).

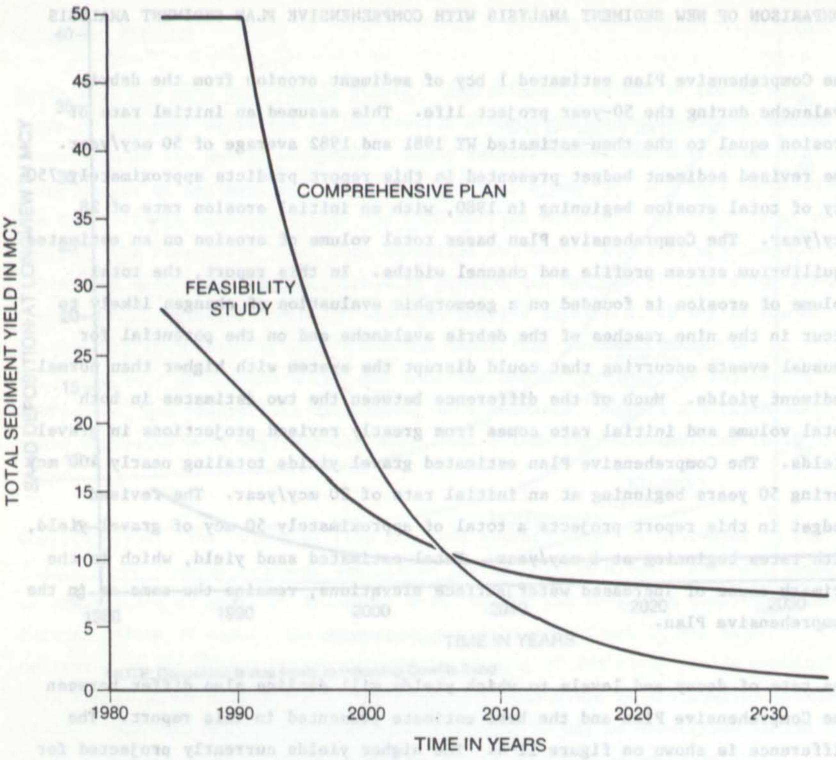


Figure II-4. Total avalanche sediment yields, Comprehensive Plan vs. Feasibility Report.

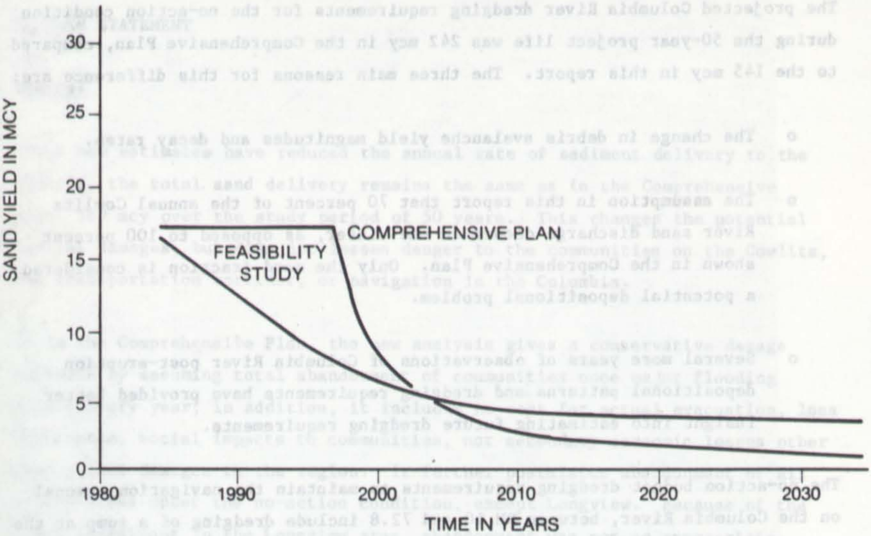


Figure II-5. Toutle River Sand Yield, Comprehensive Plan vs. Feasibility Report.

The projected Columbia River dredging requirements for the no-action condition during the 50-year project life was 242 mcy in the Comprehensive Plan, compared to the 145 mcy in this report. The three main reasons for this difference are:

- o The change in debris avalanche yield magnitudes and decay rates.

- o The assumption in this report that 70 percent of the annual Cowlitz River sand discharge occurs in the winter, as opposed to 100 percent shown in the Comprehensive Plan. Only the sand fraction is considered a potential depositional problem.

- o Several more years of observations of Columbia River post-eruption depositional patterns and dredging requirements have provided better insight into estimating future dredging requirements.

The no-action budget dredging requirements to maintain the navigation channel on the Columbia River, between RM 10 and 72.8 include dredging of a sump at the mouth of the Cowlitz River from 1985 up to 2035. This sump traps flood event sediment and prevents it from disrupting navigation in the Columbia River channel. Approximately 3 mcy/year of sand and fines will be dredged fromthis sump. Due to the geometry of the sump, about 1 mcy of the dredged material will be fines. If the sump were not present, the fines would most likely remain suspended and discharge into the Columbia without depositing.

Observations of the depositional behavior of Cowlitz and Columbia Rivers have led to changes in sediment transport and deposition estimates on those streams. Long-term sediment transport modeling, based on those observations, has resulted in revised flood elevation predictions for the Cowlitz River. Overall, the new design yield reduces the initial intensity of the sediment yields but increases the long-term rates. A full assessment of these changes on possible flood protection and sediment control alternatives are discussed later.

PROBLEM STATEMENT

General

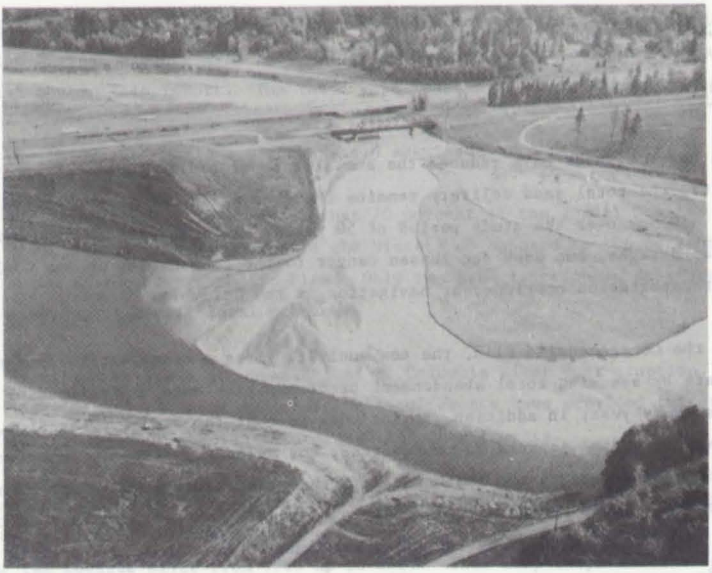
While new estimates have reduced the annual rate of sediment delivery to the Cowlitz, the total sand delivery remains the same as in the Comprehensive Plan: 380 mcy over the study period of 50 years. This changes the potential initial damages, but does not lessen danger to the communities on the Cowlitz, the transportation corridor, or navigation in the Columbia.

As in the Comprehensive Plan, the new analysis gives a conservative damage estimate by assuming total abandonment of communities once major flooding occurs every year; in addition, it includes no cost for actual evacuation, loss of revenue, social impacts to communities, nor secondary economic losses other than direct damages to the region. It further postulates abandonment of all leveed areas under the no-action condition, except Longview. Because of the large investment in the Longview area, abandonment was not an appropriate option.

Potential Flood Damages

Transportation Corridor. Total average annual damages estimated for the transportation corridor which crosses the Toutle River at its confluence with the Cowlitz River come to $12.2 million. Abandonment of the current transportation corridor is not considered a reasonable alternative. However, by 1989, transportation facilities would incur damages annually in excess of $100,000.

Castle Rock. Average annual damages estimated for the city of Castle Rock are $1.9 million. Castle Rock is the most endangered urbanized area with abandonment assumed in 1986. Figure II-6 shows the stage-frequency curve for Castle Rock.



Photograph 7. Sediment Plume from Mouth of Toutle River Entering Cowlitz River.

<u>Lexington</u>. Average annual damages estimated for the community of Lexington are $4.0 million. Damages are not considered for this community beyond 1988 because abandonment is assumed and flooding could be expected on an annual basis after that date.

<u>Kelso</u>. Average annual damages estimated for Kelso are $6.1 million. Abandonment would occur in 1987 and damages are not considered for this community beyond that time.

<u>Longview</u>. Longview is the major damage center for the study area. It contains the industrial base for this region of Washington State. Average annual damages for the city are $102.1 million. As previously stated, abandonment is not assumed for this area. Figure II-7 shows stage-frequency curve for Longview.

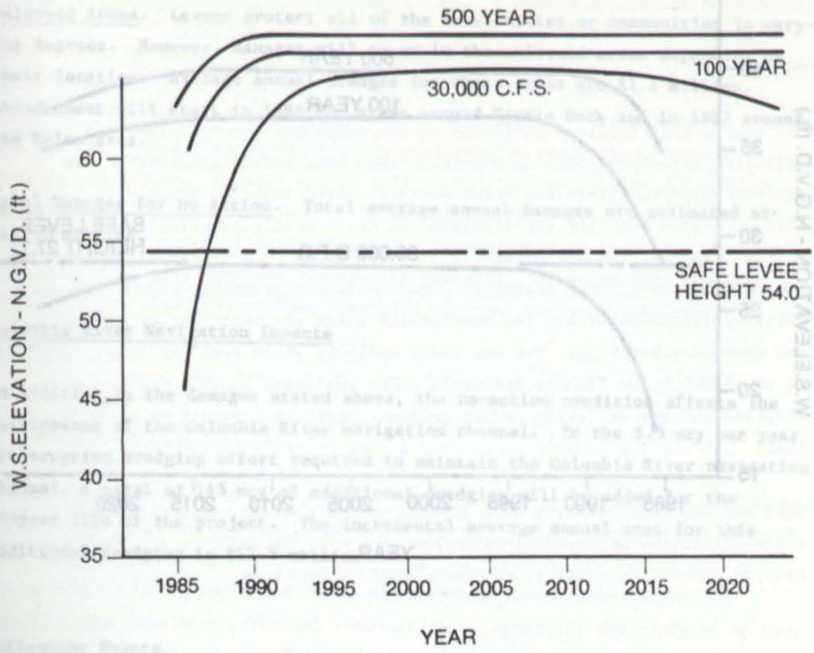


Figure II-6. Water Surface Elevations with no action at Castle Rock - RM 17.6.

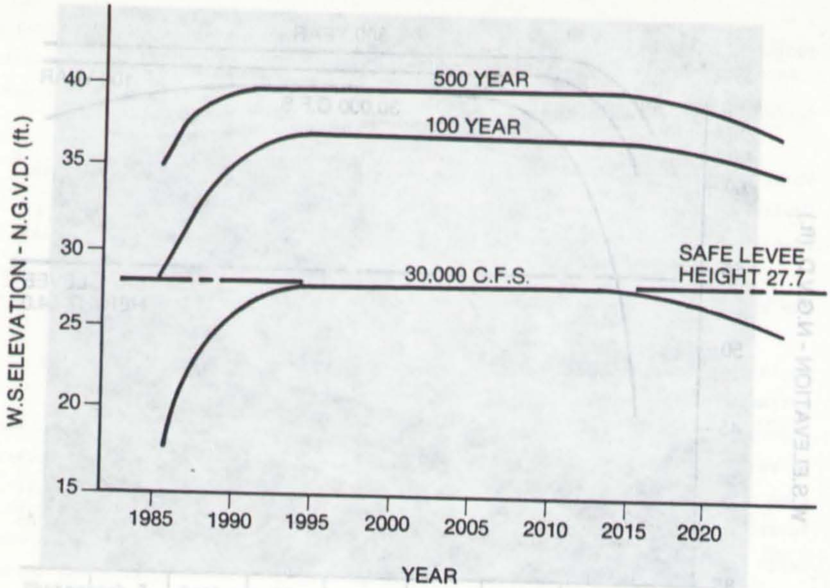


Figure II-7. Water surface elevations with no action at Longview - RM 5.5.

Unleveed Areas. Levees protect all of the above cities or communities in varying degrees. However, damages will occur in the unleveed areas depending on their location. Average annual damages for these areas are $1.2 million. Abandonment will start in 1986 for areas around Castle Rock and in 1987 around the Kelso area.

Total Damages for No Action. Total average annual damages are estimated at $127.5 million.

Columbia River Navigation Impacts

In addition to the damages stated above, the no-action condition affects the maintenance of the Columbia River navigation channel. To the 5.5 mcy per year pre-eruption dredging effort required to maintain the Columbia River navigation channel, a total of 145 mcy of additional dredging will be added for the 50-year life of the project. The incremental average annual cost for this additional dredging is $13.5 million.

Infrequent Events

In addition to the estimated damages and impacts shown above, further threat exists from such infrequent events as mudflows and large storms.

As noted earlier, mudflows and large storm events can deliver so much sediment that the Cowlitz channel would fill and all protection could be lost. Should a mudflow or major storm occur during the storm season, a real possibility exists that the channel capacity could not be restored during the winter season. Severe damages to communities and blockage of the Columbia could result if any storms followed this type of event.

IMPACTS OF NEW SEDIMENT ANALYSIS ON COMPREHENSIVE PLAN SENSITIVITY ANALYSIS

General

The sensitivity analysis conducted in the Comprehensive Plan showed a single retention structure (SRS) is generally the least costly solution to the sediment problem within the total sediment yield range of 400 mcy to 2 bcy. It also indicated that the SRS provided the least costly solution to sediment yields, ranging from approximately 30 mcy/year to 70 mcy/year. The revised sediment budget for the Feasibility Report (see appendix C) placed the new sediment estimates within the approximate range of sensitivities developed for the Comprehensive Plan. The new total sediment yield from the debris avalanche is predicted to be 750 mcy during 55 years beginning in 1980 following the eruption and the declining annual sediment yield is forecast to be 28 mcy in 1985.

This section considers the cost impacts of the revised sediment budget on the relative ranking of sediment solutions and describes additional studies necessary to insure the validity of these relative rankings.

Impacts on Single and Multiple Retention Structures

The revised sediment budget indicated the feasibility of a smaller structure if sized only for sediment storage. However, additional storage needed for sediment delivery by flood events and mudflows dictated that a structure the same size as in the Comprehensive Plan still was required. Continuing investigations of the MRS sites revealed foundation problems, creating increased costs for this option regardless of the magnitude of sediment predictions. Thus, changes in the sediment analysis had no effect on the relative ranking of solutions as presented in the Comprehensive Plan. However, costs have been recomputed for the MRS alternatives and are presented in the following chapter.

Impacts on Sediment Stabilization Basins

The new sediment analysis indicates reduced initial annual sediment delivery, suggesting a lower initial cost for the SSB solutions. However, the total

quantity of sand delivered over the project life remains virtually the same as in the Comprehensive Plan. Since dredging is highly sensitive to total volumes of material removed, costs rise quickly as convenient disposal sites reach capacity. Review of available disposal sites shows little remaining storage volume, indicating that dredging would have greater costs than shown in the Comprehensive Plan. Another factor influencing the cost of the SSB solution stems from a downward revision in the trapping efficiency of this alternative. Increasing the amount of material needing removal adds to the cost. However, investigations will continue considering dredging. Although the SSB terminology is not used, the proposed dredging utilizes the same locations, LT-1 and LT-3, and similar methods of removal.

Further Sensitivity Analysis

Based on the revised sediment budget, investigations were performed to determine if the relative ranking between the MRS and SRS alternatives had changed. The results are presented in the following chapter. Further study also compared various sized SRS's and their accompanying downstream dredging to identify the most cost-efficient combination of structure and dredging at each SRS site. In addition, the National Economic Development (NED) plan formulation process conducted a sensitivity analysis of the impacts of varying quantities of sediment on the proposed plan.

Base Condition

Rationale. As discussed above, a base condition has been selected which is defined as the without-project condition in this report. This base condition acknowledges the Federal Government's commitment to protect the communities along the Cowlitz River and reflects interim actions under authority of PL 98-63. The base condition, rather than the no-action condition, serves as the probable future against which all alternatives will be measured.

Methodology. The Cowlitz River's dynamic nature pointed out the danger of selecting a condition which might prove unachievable on a long-term basis.

Therefore, the Corps chose a condition existing at a given point in time. Since levels of protection on the Cowlitz vary from a high in summer (just after dredging) to a low at the end of winter, the selected base condition was that level of protection documented in the Cowlitz River Survey conducted during November and December 1983. This level of protection was measured against the permanent levees rather than the temporary structures built as a flood-fight activity and considered inadequate as a long-term solution. In sum, the level of protection chosen reflects these factors:

- The interim dredging represents one aspect of a long-term commitment by the Federal Government.

- The November-December survey documented a realistic level of protection. Concern existed that too high a level of protection established against the permanent levees would be impossible to achieve by dredging.

- The November-December 1983 river geometry provides an accurate measurement of river conditions upon which to base damage and benefit calculations.

- The levels of protection existing in the November-December survey, based upon current estimates of sedimentation, vary from about 60-year protection at Longview to 10-year protection at Castle Rock and fall between the maximum and minimum levels achieved that year.

Erosion and sediment transport within the Toutle River Basin will be the same for the base condition as for no action (appendix C). In the Cowlitz River, base condition deposition will be slightly higher than under no action and dredging will be performed at LT-1 and LT-3 to maintain interim flood protection. Dredging also will be conducted at the mouth of the Cowlitz River to maintain the Columbia River navigation channel. A summary of base condition sediment movement is presented in table II-1. As that table shows, 450 mcy of sediment will be transported through the Columbia River system. Over 60 percent of that material will be silt and clay.

TABLE II-1

BASE CONDITION SEDIMENT MOVEMENT

(mcy)

50-year Project Life

(1985-2035)

Estimated Avalanche Erosion		
	750	Total Erosion by 2035
	-99	Previously Eroded
	651	Total 50-Year Erosion
Toutle River	↓	
	651	Yield to
	+23	Erosion
	-89	Deposition (50 upstream gravel +39 dredging)
Cowlitz River	↓	
	585	Yield to
	+10	Erosion
	-74	Deposition (to be dredged)
Columbia River	↓	
	521	Yield to
	0	Erosion
	-71	Deposition (to be dredged)
	↓	
	450	To Move through Columbia River
TOTAL DREDGING REQUIRED	184	

The benefits of the base condition as well as the economic justification used for economic evaluation of alternatives are described in the National Economic Development Plan, chapter IV.

Evaluation of Emergency Structures

In late 1982, the Corps placed temporary structures on the tops of the levees along the Cowlitz River as an emergency measure to improve the margin of safety

against overtopping during the winter of 1982-83 to the leveed areas of Longview, Kelso, Lexington, and Castle Rock. The Corps added between 1 and 5 feet (2.5 feet average) of various construction and structural materials to the top of approximately 10 miles of levees to help offset the uncertainty of winter sediment deposition, expected to exceed 3 feet in the Cowlitz River. None of these emergency measures met Corps design requirements for permanent structures, as this work was designed to provide only additional freeboard for a one-time event. The space available for construction and the safety factor of the existing levee sections determined final temporary levee configurations. Construction materials included quarry waste, sand, concrete stoplogs, highway median barriers, geotextiles, sandbags, and wood. This construction was intended to prevent overtopping of the levees during short-duration events but not to withstand high or long-duration floods or sequential events. Should the levees experience such events, they would suffer damage and need rebuilding before again providing reliable freeboard.

The 1982 emergency actions attempted to provide protecton to structures located in the flood plain behind the levees during the single occurrence of an extreme event. These measures should not be construed as providing the same protection for lives, since temporary evacuation is required as soon as levels reach the safe-water height of the permanent levees. Also, the temporary measures do not provide the same long-term property protection as the permanent structures, because sandbags or other temporary measures are removed once the flood event has passed. However, in the case of the lower Cowlitz River, the Corps left the temporary floodfight measures in place, recognizing that permanent flood control measures would not be implemented for several years and the extreme difficulty in mounting an effective floodfight during the interim period.

As indicated in various interim reports, these emergency measures have provided temporary 100-year emergency protection for the single occurrence of an extreme event. The emergency level of protection is provided by freeboard assumed at 3 feet below the temporary levee crest. By comparison, the safe level of protection for the permanent levee is based on a detailed analysis of the structures and varies from 3 to 6 feet below the crest of the permanent levee. Since the protection provided by the temporary measures and structures is very limited, the levels of protection used in the base condition analysis of this report do

not agree with those given in various interim measures report. A discussion of these levels of protection can be found in appendix D, exhibit 1. Enumerated below are additional reasons these temporary measures are not used as a basis for permanent protection (for explanation of temporary measures, see last paragraph, page II-30).

Since the eruption, an agressive monitoring program on the Cowlitz River provides some preparedness for floodfight operations to protect leveed areas. Based on the existing conditions, it would be impractical to mount successful floodfight operations for all the existing levees for the following reasons:

a. Historically, the Cowlitz River has been difficult to successfully floodfight due to its high velocity and rapid rate of rise. Changes in the Toutle basin watershed due to the eruption of Mount St. Helens have made the Cowlitz even more unpredictable. The National Weather Service feels it can give approximately 6 hours warning of an impending flood peak arrival. From the time the Corps receives a forecast of an impending flood peak and declares a floodfight, it needs over 10 hours of lead time to mobilize contractors and their equipment to protect the threatened areas. Hence, effective floodfight operations could not be mounted in time.

b. Some levees, such as the Castle Rock levees, have no physical room on top of the critical sections to perform floodfights. The space is filled by the temporary raises and no area exists for either equipment or additional protection materials such as sandbags. However, the temporary work is the same as that which would take place in a normal floodfight.

c. In addition to the lead-time requirement listed above, all of the levee systems requiring emergency floodfight operations are crossed by the major evacuation routes leading from low-lying areas or are immediately adjacent to densely inhabited areas. Therefore, it is anticipated that contractor access to many worksites will be seriously inhibited by evacuees attempting to move in the opposite direction away from the threatened areas. This worksite congestion would undoubtedly delay or otherwise interfere with floodfight operations and adversely influence their effectiveness.

A comparison of the base condition levels used for analysis in this report and the level of protection which exist resulting from temporary levees and interim dredging along Cowlitz River are shown below.

Table II-2
COMPARISON OF LEVELS OF PROTECTION

	Levels of Protection*	
Location	Base Condition Used for Analysis	Existing Condition with Temporary Levees and Interim Dredging**
Longview	60 year	100+ year
Kelso	20 year	100 year
Lexington	40 year	100+ year
Castle Rock	10 year	100+ year

*December 1983 survey and August 1984 sediment adjustments.

**Conditions in 1984 approximate those shown in the table above. Based upon the most recent estimates of sediment made during 1984, necessary dredging, and maintenance, rehabilitation, and reconstruction of the temporary emergency protection levees will be accomplished as required by PL 98-63. Levels of protection are subject to variation over the calendar years. See Appendix D, exhibit 1.

e. The Supplemental Appropriations Act of 1983 (PL 98-63) authorized the Corps of Engineers to implement and maintain flood control measures on the Cowlitz and Toutle Rivers. This legislation was enacted to assure flood protection for developed areas in the vicinity of each river against a 100-year flood and to reduce sediment flow into, and the potential blockage of the Columbia River navigation channel.

The emergency levee raises were constructed without benefit of a complete design process. As a result, the emergency structure cross sections are, in many cases, substandard according to current design criteria and do not provide an adequate factor of safety. If the river encroached on these temporary levees, the levees could fail or at least pass so much water as to render them unsafe. Therefore, evacuation of residents has been a requirement as soon as water levels reach the safe water height of the permanent levees.

Use of the emergency structures could result in damages, if implemented as a long-term solution. Moreover, even if the leakage through the structure were solved and the river bed allowed to raise, the old levees underneath the raised sections could become saturated. Since the Corps did not design these structures for continuous saturation, serious interior drainage problems would ensue. At best, this situation would be remedied by costly pumping plants; at the very worst, failure of a section of the permanent levee could occur.

The freeboard provided by the emergency structures was not intended to undergo prolonged inundation. These raised portions are, therefore, not considered a part of the permanent levee except as they provide some tolerance for inaccuracies in predicting water surface elevations during a single storm event. Some benefits are attributable to the freeboard provided by the emergency structures. The Corps evaluation process allows benefits for half the freeboard. A sensitivity analysis presented in appendix B studied whether that additional value would significantly enhance the base condition. The results indicated that it reduced the base condition's residual average annual damages by less than 10 percent. Hence, the impact on plan evaluation of giving the temporary levees benefits as freeboard is considered insignificant.

Costs for Maintaining the Base Condition. The costs shown below reflect the 50-year total and average annual cost required to provide the base condition at 1984 prices using an 8-1/8 percent interest rate. The detailed costs by year are shown in exhibit 1 of appendix D. By comparison, 1983-84 dredging costs to remove 12.4 mcy came to $22.5 million.

Monitoring Cost	$ 32,500,000
Toutle River Dredging (37 mcy)	68,200,000
Cowlitz River Dredging (76 mcy)	219,700,000
Columbia River Dredging (71 mcy)	170,700,000
Contingency (20%)	98,100,000
TOTAL COST	$589,200,000
AVERAGE ANNUAL COST	$ 23,300,000

Risks Associated with Base Condition. Certain risks are inherent with any dredging solution. Dredging is primarily a reactive measure. Monitoring indicates when the protection to a community would warrant dredging. If the level of protection is measured during the summer, there is little problem; but if it decreases during the storm season, there is little chance of restoring full protection before the end of the winter.

If all the dredging were done continuously at LT-1 and LT-3 sites, there would be a limitation to site efficiency and not all the sediment moving through the river could be removed. This is due to physical limits on how much material can be handled by dredging equipment in a given period of time; moreover, the sediment delivered by one storm could fill or exceed the capacity of a basin. Since storms in this region can occur in series, a second storm could bring another wave of sediment before the basin could be dredged of the earlier deposit. As a result, only part of the sediment being transported could be trapped and removed under these conditions. A large volume of sediment could pass into the lower Cowlitz and Columbia Rivers, creating a potential for flooding on the Cowlitz and blockage of navigation on the Columbia.

Conclusions

As described, the problem statement for the feasibility study reflects recent changes to the sediment budget. The problem statement fully acknowledges the serious continuing threat to communities on the Cowlitz River, to the transportation corridor crossing the Toutle River, and to navigation on the Columbia River. Originally, the problem statement assumed a no-action condition. This did not reflect the Federal commitment to protect threatened communities, as

indicated by the interim dredging authorized under PL 98-63. The revised problem statement uses as the base condition a without-project status but presumes continued dredging.

The without-project base condition is now the point of comparison for all future alternatives in this report. The damages claimed for those alternatives will reflect only those damages which exceed the base condition, since the benefit of each alternative is based on the net difference from the base condition (see chapter IV). All future discussions of alternatives and their costs must reflect the protection provided by the base condition.

Investigations performed on the sensitivity analysis conducted in the Comprehensive Plan showed no change in rankings. Further sensitivities have been conducted on the retention structure alternatives and the dredging required to maintain the base condition. These identified the ranges in cost, should sediment delivery vary significantly from the revised estimate.

A developed area will be deemed as having 100-year flood protection when the predicted 100-year flood elevation is 3 feet or more below the top of the levee. The top of the levee is considered to be the higher of either the top of the permanent levee or the top of the temporary levees that were constructed on the permanent levees during the winter of 1982-83, depending on location. This 100-year protection is considered adequate for protection of property only. Since these temporary levee raises could not be constructed to Corps standards because of time limits and rights-of-way constraints, they do not offer the same degree of proteciton of life as standard Corps levees. This is particularly true in the Castle Rock area where evacuation will be necessary prior to reaching the 100-year flood elevation to insure adequate protection of lives.

CHAPTER III - FURTHER INVESTIGATIONS

INTRODUCTION

Following the development of the revised sediment budget, new cost estimates were formulated to recheck the relative ranking between the MRS and SRS alternatives. These new estimates not only considered the revised sediment projections, but also looked at new site information developed since completion of the Comprehensive Plan. Specifically, the new estimates incorporated information from foundation studies and topographic surveys conducted at LT-3 and Kid Valley sites, similar to ones already completed at the Green River site.

This chapter presents new costs for all the MRS combinations and compares the structures and associated costs with the SRS alternative. It also carries out a cost comparison between different sized structures at all SRS sites.

MULTIPLE RETENTION STRUCTURES (MRS) COST REVISIONS

Description

This study examined the proposal for two or three structures placed along the North Fork and main stem Toutle Rivers, sized to store the materials eroding from the debris avalanche. The structures would be constructed in sequence and would not require dredging of the material trapped by the structures.

Sites available for constructing debris retention structures exist at LT-3, Kid Valley, and Green River. Initial construction would begin at the lower site on the river, LT-3; and structures would be added upstream until sufficient storage existed to handle the eroded material.

The heights of the structures would vary, depending on the amount of material retained at a given location. All structures would be built in a single stage although the larger structures at Kid Valley and Green River could be built in stages. These retention structures would be gravity dams constructed using

roller-compacted concrete techniques. The spillway, also roller-compacted concrete, would have gravity sidewalls with a raised concrete overflow section to control the level of sediment deposition behind the structure. The phasing of subsequent dams would depend upon the full utilization of the preceding structure's storage space.

This strategy would limit the operations and costs required to remove material, as long as the structures have sufficient storage capacity to capture all the sands eroding from the debris avalanche. Construction in sequence allows flexibility in dealing with sediment movement. Downstream dredging would be required to handle sediment transport during construction of the first retention structure, and for several years thereafter, until the river system downstream of the structures stabilizes.

Results

Foundation explorations revealed that LT-3 required considerably more excavation than preliminary estimates. Moreover, new studies showed the need for additional foundation work for the left abutment at the Green River site. New topographic information at LT-3 called for saddle dams along the ridgeline of the basin to take full advantage of the capacities estimated for that site. These structures are necessary to prevent flows from diverting to other adjacent basins as they overtop the low spots of the Toutle Basin around LT-3. Detailed topography studies also improved storage estimates for the Kid Valley site.

The estimates in table III-1 are based on the revised sediment budget. They provide at least the same protection given by the base condition assumed for this report. The MRS estimates yield benefits equal to the lowest cost SRS, the 177-foot-high Green River structure, based on average annual sediment deliveries.

Other Considerations

Relocations. Real estate costs and land requirements are greater for multiple sites than for single sites. Impacts associated with acquisition are also multiplied because of the increased number of land owners involved.

Fisheries. Under the MRS plan, the first structure built is LT-3. This effectively cuts off upstream fish migration. With each additional structure, chances of successful upstream movement for fish becomes more remote. Downstream migrants also suffer higher mortalities under the MRS option. Greater impacts occur to wildlife habitat for multiple structures than for single structures. State and Federal wildlife agencies oppose multiple structures.

Summary

All combinations of the MRS shown are based on the most recent sediment, foundation and topographic information. These combinations provide at least the base condition level of protection and have outputs or benefits equal to the SRS shown. Both in total and average annual costs, the SRS clearly represents the more cost-efficient solution. Therefore, the MRS alternative is dropped from the formulation process and all further comparisons will consider only the SRS and dredging for the base condition.

Clearly, the total costs associated with MRS structures are high. In order to compare the MRS combinations with the SRS, the study sized the SRS so that its downstream actions equaled those of the MRS. This resulted in equal benefits of flood damage reductions and equal reductions to dredging on the Columbia River. Table III-1 shows that comparison.

Table III-1

MRS-SRS Cost Comparison [1]

Combination (Dam height)	Structure Cost[3] ($ M)	Structure Storage (mcy)	Downstream Action Costs: Cowlitz Toutle[2] ($ M)	Downstream Action Costs: Columbia[2] ($ M)	Total ($ M)	Average Annual ($ M)
MRS						
LT-3 (132 ft)	134.2[3]	34				
Kid Val. (268 ft)	236.0	248				
O&M/Monitoring	42.0					
			64.1	33.1	509.4	30
LT-3 (132 ft)	134.2[3]	34				
Kid Val. (118 ft)	79.0	19				
Green R. (153 ft)	137.9	184				
O&M/Monitoring	39.0					
			64.1	33.1	487.3	28
LT-3 (132 ft)	134.2[3]	34				
Green R. (163 ft)	143.7	259				
O&M/Monitoring	42.0					
			64.1	33.1	417.1	25
Kid Val. (118 ft)	79.0	19				
Green R. (168 ft)	148.0	279				
O&M/Monitoring	42.0					
			64.1	33.1	366.2	22
SRS						
SRS at Green R.						
Green R. (177 ft)	150.0	299				
O&M/Monitoring	45.0					
			64.1	33.1	292.2	18

---

1 Exact comparison between MRS and SRS costs at each site cannot be made as differences in O&M and monitoring costs exist under the two schemes.

2 All projects have equal downstream action requirements and costs.

3 Does not include $60 million for saddle dam at LT-3, since constructing a dam upstream limits the amount of additional aggregation behind the structure and negates the need for such a dam. The SRS does include a saddle dam in its costs.

SINGLE RETENTION STRUCTURE SITE DEVELOPMENT

General

Following the development of the revised sediment budget and the decision to concentrate on the SRS, a refined methodology identified a general area of optimization between downstream actions and structure size. The analysis considered a wide range of structure sizes for each SRS site. The study then compared total project costs, including dredging on the Cowlitz and Columbia Rivers for each size of structure at each site. An optimized structure would be one having a total project cost less than either the next smaller or next larger structure.

Description

Structure. Structures developed for the following cost estimates would be built of roller compacted concrete with a concrete spillway. The size of the structures vary depending on the sites. Spillways are 600 feet wide at all sites except LT-3, where site limitations permit a width of only 500 feet.

Spillways would empty into stilling basins constructed of concrete. Some form of regulating outlet has been assumed for all but the smallest structures with the cost for an intake tower included in the estimates. Structure design includes fish by-pass facilities for anadromous fish as discussed in Section V.

The trap efficiencies of the structure vary in relation to their size and sediment capacities and retention times. These varying efficiencies are reflected in the costs of downstream actions and are included in the total project costs. All structure costs shown below assume one-stage construction. Analysis will be performed on the preferred plan for staging feasibility.

Downstream Actions. Most downstream dredging would occur on the Toutle River at LT-1 and possibly LT-3. Once the disposal areas for those sites are full or because of some threat to a community, dredging would take place on the Cowlitz. Cost of a monitoring program for the sediment movement is included in the project costs. This monitoring program is critical for identifying dredging locations on the Cowlitz River during the first few years of the project's life. Costs for dredging include real estate for disposal areas and necessary hauling of material.

Engineering considerations include dredging in the Columbia at the mouth of the Cowlitz River. Costs reflect disposal in areas close-by until those areas become full and additional expenses are incurred for transporting material to more distant locations. It is anticipated that material not deposited at the mouth of the Cowlitz will have little impact downstream in the Columbia.

Costs. Costs for all alternatives include real estate, contingency, engineering and design, and supervision and administration. Detailed costs are found in appendix D.

LT-3

General. As previously discussed, foundation explorations discovered greatly increased construction costs for all sizes of structures at this site. Questionable foundation conditions exist along the ridgeline between the Toutle River and Salmon Creek basins, requiring the use of saddle dams. This site has very limited capacity. Costs for an SRS at the LT-3 site are shown in table III-2.

Table III-2

LT-3 Site

Dam Height (ft)	Maximum[1] Capacity (mcy)	50-Year[2] Trapping Capability (mcy)	Structure Costs ($M)	Downstream Actions Cowlitz/ Toutle $ (mcy)	Downstream Actions Columbia $ (mcy)	Total Costs[3] ($M)
107	21	21	119.1	326.2 (98)	193.5 (68)	638.7
132	73	73	225.7	255.1 (80)	185.0 (65)	665.8
162	169	147	398.0	172.1 (59)	158.0 (57)	728.0
BASE CONDITION						589.2

1. Capacity based on a pool with an S/2 upstream material slope.
2. Trapping capability based on 50-year project life and average annual sediment delivery.
3. Price level 1984.

Real Estate Requirements. The range of real estate requirements are shown in table III-3.

Table III-3

LT-3 Real Estate Requirements[1]

Dam Height (ft)	Acreage	Number of Ownerships	Number of Occupied Improvements	Total Real Estate Costs
107	1,410	73	13	6,350,000
162	2,870	92	13	13,900,000

1. Real estate costs included in Table III-2.

Other Considerations.

a. Saddle Dams. These structures are costly to build and would require further foundation investigations at this site.

b. Fishery Impacts. Fishery impacts would occur because fish migration to both Green River and the South Fork Toutle, which have important fisheries, would be blocked. Environmental interests have concerns about any structure below the confluence of the Green River. State and Federal agencies opposed this site for a structure.

Kid Valley Site

General. A high dam is required in this area because of the narrow shape of the valley; however, adequate capacity exists at this site. A structurally competent foundation exists.

Table III-4

Kid Valley Site

Dam Height (ft)	Maximum[1] Capacity (mcy)	50-Year[2] Trapping Capability (mcy)	Structure Costs ($M)	Downstream Actions Cowlitz/ Toutle $ (mcy)	Downstream Actions Columbia $ (mcy)	Total Costs[3] ($M)
118	35	35	112.0	267.7 (97)	187.2 (66)	575.9
163	87	87	149.0	203.7 (78)	170.5 (61)	523.2
208	174	174	187.7	114.9 (52)	154.8 (55)	457.4
243	281	270	238.1	64.1 (29)	126.4 (47)	428.6
318	726	463	306.0	59.7 (27)	33.1 (15)	398.8
BASE CONDITION						589.2

1. Capacity based on a depositional area with an S/2 upstream material slope.
2. Trapping capability based on 50-year project life and average annual sediment delivery.
3. Price level 1984.

Real Estate Requirements. The range of real estate requirements for Kid Valley site are shown on table III-5.

Table III-5

Kid Valley Real Estate Requirements[1]

Dam Height (ft)	Acreage	Number of Ownerships	Number of Occupied Improvements	Total Real Estate Costs
118	1,700	46	10	$ 5,800,000
318	7,000	94	34	20,850,000

1. Real estate costs included in table III-4.

Other Considerations.

a. Fishery Impacts. Significant impact to upstream fisheries would occur with a structure at this site. Fisheries agencies oppose any structures below confluence of Green River. Sediment backup would affect fisheries on both the Green River and the North Fork Toutle River.

b. Relocations. No utilities relocations are proposed for alternatives with dam heights greater than 208 feet, since real estate acquisitions preclude the need for such actions. However, relocation of State highway 504, which runs parallel to the North Fork Toutle at the Kid Valley and Green River sites, may be necessary. See chapter X for further discussion.

Green River Site

General. A structurally competent foundation also exists here, as well as adequate capacity.

Table III-6

Green River Site

Dam Height (ft)	Maximum[1] Capacity (mcy)	50-Year[2] Trapping Capability (mcy)	Structure Costs ($M)	Downstream Actions Cowlitz/Toutle $ (mcy)	Downstream Actions Columbia $ (mcy)	Total Costs[3] ($M)
77	40	40	107.8	290.6(100)	187.2 (66)	585.6
112	113	112	147.5	184.0 (73)	170.5 (61)	502.0
142	234	184	171.4	92.8 (42)	145.3 (50)	409.5
177	411	299	195.0	64.1 (29)	33.1 (15)	292.2
202	581	395	226.3	59.7 (27)	33.1 (15)	319.1
272	1162	463	310.9	59.7 (27)	33.1 (15)	403.7
BASE CONDITION						589.2

1. Capacity based on a depositional area with an S/2 upstream material slope.
2. Trapping capability based on 50-year project life and average annual sediment delivery.
3. Price level 1984.

Real Estate Requirements. The range of real estate requirements for Green River site are shown on table III-7.

Table III-7

Green River Real Estate Requirements[1]

Dam Height (ft)	Acreage	Number of Ownerships	Number of Occupied Improvements	Total Real Estate Costs
77	1,500	18	7	$ 4,000,000
272	8,700	24	9	17,300,000

1. Real estate costs included in table III-6.

Other Considerations.

a. Fishery Impacts. This structure would have no negative impact on fish movement or habitat of the Green and South Fork Toutle Rivers. Fish migration upstream of the SRS is affected. Agencies favor this site with some form of fish passage provided.

b. Relocations. No utilities relocations are proposed for alternatives with dam heights greater than 142 feet, since real estate acquisitions preclude the need for such actions. However, relocations of State highway 504, which runs parallel to the North Fork Toutle at the Kid Valley and Green River sites, may be necessary. See chapter X for further discussion.

Table III-8

Summary of Costs

Site and Dam Height (ft)	Maximum[1] Capacity (mcy)	50-Year[2] Trapping Capability (mcy)	Structure Costs ($M)	Downstream Actions: Cowlitz/ Toutle $ (mcy)	Downstream Actions: Columbia $ (mcy)	Total Costs ($M)
LT-3						
107	21	21	119.1	326.2 (98)	193.5 (68)	638.7
132	73	73	225.7	255.1 (80)	185.0 (65)	665.8
162	169	147	398.0	172.1 (59)	158.0 (57)	728.0
Kid Valley						
118	35	35	112.0	267.7 (97)	187.2 (66)	575.9
163	87	87	149.0	203.7 (78)	170.5 (61)	523.2
208	174	174	187.7	114.9 (52)	154.8 (55)	457.4
243	281	270	238.1	64.1 (29)	126.4 (47)	428.6
318	726	463	306.0	59.7 (27)	33.1 (15)	398.8
Green River						
77	40	40	107.8	290.6(100)	187.2 (66)	585.6
112	113	112	147.5	184.0 (73)	170.5 (61)	502.0
142	234	184	171.4	92.8 (42)	145.3 (50)	409.5
177	411	299	195.0	64.1 (29)	33.1 (15)	292.2
202	581	395	226.3	59.7 (27)	33.1 (15)	319.1
272	1162	463	310.9	59.7 (27)	33.1 (15)	403.7

1. Capacity based on a depositional area with an S/2 upstream material slope.
2. Trapping capability based on 50-year project life and average annual sediment delivery.

Summary

Of the 14 various sized structures considered, the 177-foot-high SRS at Green River is the least costly. The following chapter will examine the benefits of each of these structures and identify the one which provides the maximum net benefits. By definition, it will become the NED plan.

CHAPTER IV - NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

GENERAL

The Comprehensive Plan screened thirteen alternative measures and eliminated all but five. The five management strategies identified during plan formulation constituted the most feasible alternatives for meeting the study objectives and providing a long-term solution to the potential threat of flooding and navigation channel blockage.

The formulation process assumed that the existing Columbia River navigation channel would continue to be maintained to its 40-foot authorized depth, with any flood protection alternative evaluated. This navigation channel is a significant regional transportation resource which carries some 30 million tons of commerce annually. Political, social, and economic considerations warrant the maintenance of this navigation channel under all project conditions.

In the Comprehensive Plan, each management strategy was designed to yield the same benefits, or level of protection, measured against a no-action condition. Comparison was made of the various measures based upon cost of implementation to determine which of them yielded the greatest net benefit. Based upon this analysis, single retention structures (SRS) cost substantially less than any of the alternative measures considered while providing the same level of benefits.

Subsequent analyses tested the sensitivity of single retention structures to changes in the anticipated rate of sediment erosion and to greater and lesser total volumes delivered over the study period. This sensitivity analysis showed that single retention structures, by virtue of their storage capacity, provided the greatest allowance for variation in total volume and for changes in the rate of sediment erosion and transport to the downstream channel. It also confirmed that SRS's were relatively insensitive to shifts in total volume and rate of delivery.

Following the above analysis, the Feasibility Report focused on single retention structures for further evaluation and refinement.

BASE CONDITION

The base condition defined for this Feasibility Report is the channel capacity existing in the Cowlitz River as established by an onsite survey performed in November-December 1983. This capacity represents a constant level of protection which is sustainable over the long run through ongoing dredging activities. This interim dredging was authorized by PL 98-63 and is consistent with the recent levels of funding for Cowlitz River dredging. Therefore, the base condition fully represents the without project condition described in the Water Resource Council's Principles and Guidelines. It is the condition against which all alternatives are compared. Figures IV-1 and IV-2 show the water surface elevations for Castle Rock (RM 17.6) and Longview-Kelso (RM 5.5), respectively, under base condition measures.

The water surface elevations for the base condition are to remain constant, not only during ongoing dredging activities, but also in the future when the Cowlitz River stabilizes. The amount of interim dredging is determined by actual deposition. Therefore, sediment removal can be annually adjusted to maintain a constant level of protection or water surface elevation. This level, resulting from PL 98-63 sediment removal will be maintained by the natural stabilization of the river in the future when channel deposition is offset by erosion.

The evaluation process contained in this study examines the impact of each alternative SRS upon the base condition, both in terms of reducing flood damages and in preventing blockage of the navigation channel. This is a reasonable approach because any action which reduces sediment movement into the Cowlitz and Columbia Rivers addresses both flood control and navigation problems. The final screening of alternatives to identify the NED plan includes the impact each alternative will have on the costs of maintaining the Columbia River navigation channel and the degree of flood protection afforded along the Cowlitz River.

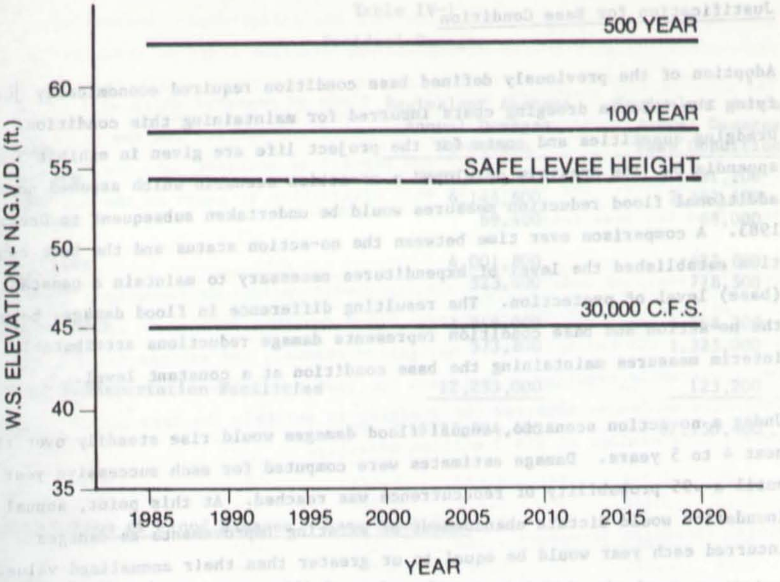


Figure IV-1. Water surface elevation for base condition at Castle Rock (RM 17.6)

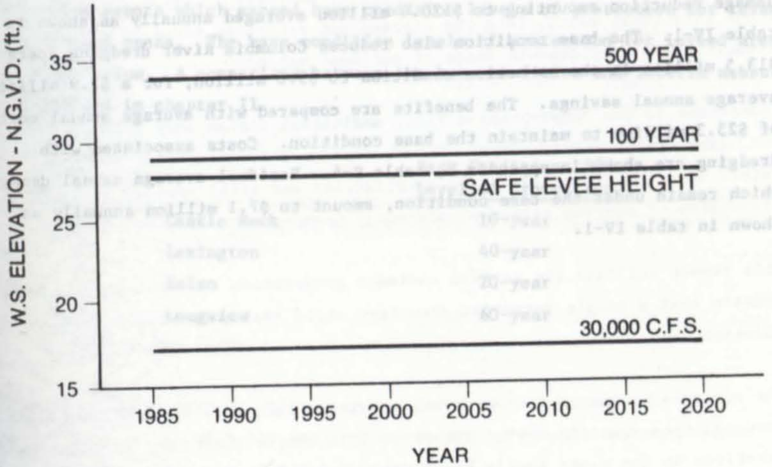


Figure IV-2. Water surface elevation for base condition at Longview-Kelso (RM 5.5).

Justification for Base Condition

Adoption of the previously defined base condition required economically justifying the interim dredging costs incurred for maintaining this condition. Dredging quantities and costs for the project life are given in exhibit 5 of appendix D. The analysis developed a no-action scenario which assumed no additional flood reduction measures would be undertaken subsequent to December 1983. A comparison over time between the no-action status and the base condition established the level of expenditures necessary to maintain a constant (base) level of protection. The resulting difference in flood damages between the no-action and base condition represents damage reductions attributable to interim measures maintaining the base condition at a constant level.

Under a no-action scenario, annual flood damages would rise steadily over the next 4 to 5 years. Damage estimates were computed for each successive year until a .95 probability of reoccurrence was reached. At this point, annual inundation would dictate abandonment of existing improvements as damages incurred each year would be equal to or greater than their annualized value.

Average annual net benefits of $105 million result from maintaining the base condition instead of the no-action status. These benefits consist of flood damage reduction amounting to $120.4 million averaged annually as shown in table IV-1. The base condition also reduces Columbia River dredging costs of $13.5 million in the no-action condition to $5.6 million, for a $7.9 million average annual savings. The benefits are compared with average annual costs of $23.3 million to maintain the base condition. Costs associated with dredging are shown in appendix E, table E-4. Residual average annual damages, which remain under the base condition, amount to $7.1 million annually as shown in table IV-1.

Table IV-1

Residual Damages

Reach	Equivalent Average Annual Damages No-Action	Equivalent Average Annual Damages Base Condition
Longview	$102,109,400	$ 181,200
Kelso	6,144,600	2,382,400
Unleveed	69,400	68,000
Lexington	4,001,800	623,800
Unleveed	523,400	778,500
Castle Rock	1,849,000	1,668,300
Unleveed	573,800	1,325,000
Major Transportation Facilities	12,233,000	123,200
Total	$127,504,400	$7,150,400

Description of Flood Damages - Base Condition

Although interim measures will be undertaken to maintain the base condition, the volatile and dynamic sediment movement into the Cowlitz River prevents eliminating all possible flooding and damages Residual damages will result from flood events which exceed base condition levels of protection for leveed and unleveed areas. The base condition levels of protection for leveed areas are shown below. A comparison between the base condition and interim measures is contained in chapter II.

	Base Condition 1983 Level of Protection
Castle Rock	10-year
Lexington	40-year
Kelso	20-year
Longview	60-year

WITH-PROJECT CONDITION

The with-project condition consists of plans or measures which will improve upon the base condition previously described and address the two major study objectives relating to transport and deposit of sediment into the Cowlitz and Columbia Rivers. The benefit of each alternative is based on the net difference from the base condition.

Benefits realized under a with-project condition include reductions in the $7.1 million residual average annual flood damages, savings in costs required to maintain the Columbia River navigation channel, and savings in dredging costs currently required to maintain the base condition on the Cowlitz River. The costs no longer incurred for dredging to maintain the base condition amount to a savings of $23.3 million annually.

Single Retention Structure

As described earlier, the formulation and evaluation process contained in the Comprehensive Plan identified single retention structures as the most efficient and effective solutions. Sensitivity analyses likewise indicated that these structures would yield the highest net return in terms of economic efficiency over a considerable range of sediment volumes.

Subsequent to the Comprehensive Plan, additional design work refined the cost and structural criteria of SRS. These studies determined that single-staged, rather than incrementally-staged construction was still cost effective. A discussion of staging versus single-stage construction is found in appendix D.

This report utilizes the revised sediment projections and delivery rates to confirm that a single retention structure still represents the optimum solution.

The analysis evaluates various sizes of single retention structures, each constructed to a specific design elevation in a single construction phase. Three locations in the upper Toutle River watershed (LT-3, Kid Valley, and Green

River) are studied. Each option and its costs are shown below. Given the revised estimates of total delivery and changes in delivery rates, reanalysis of the original plans or management strategies affirm that single retention structures are the most cost efficient plan.

Table IV-2

Summary of Costs

Site and Dam Height (ft)	50-Year[1] Trapping Capability (mcy)	Structure Costs ($M)	Downstream Actions Costs ($M)	Downstream Actions Volume (mcy)	Total Costs ($M)	Average Annual Costs ($M)
LT-3						
107	21	119.1	519.6	166	638.7	26.7
132	73	225.7	440.1	145	665.8	27.8
162	147	398.0	330.0	116	728.0	34.0
Kid Valley						
118	35	112.0	463.9	163	575.9	23.5
163	87	149.0	374.2	139	523.2	21.8
208	174	187.7	269.7	108	457.4	20.8
243	270	238.1	190.5	76	428.6	22.2
318	463	306.0	92.8	42	398.8	26.2
Green River						
77	40	107.8	477.8	166	585.6	23.9
112	112	147.5	354.5	134	502.0	20.3
142	184	171.4	238.1	95	409.5	18.0
177	299	195.0	97.2	44	292.2	17.9
202	395	226.3	92.8	42	319.1	20.0
272	463	310.9	92.8	42	403.7	25.8
BASE CONDITION[2]			589.2	184	589.2	23.3

1. Trapping capability based on 50-year project life and average annual sediment delivery.
2. Level of protection varies with area. Under the base condition, comparisons varied from 60-year level of protection at Longview to 10-year level protection at Castle Rock.

Identification of NED Plan

The NED plan is the measure which provides the greatest net benefit to the nation's economy. As with the preliminary screening process and subsequent

ordering of alternatives, maximization of net benefits guides the process of siting and sizing the SRS and identification of the NED plan.

The costs considered in the analysis consisted of all site preparation and construction expenditures expressed in terms of annual amounts over a 50-year period. The analysis also presents cost estimates for dredging and disposal of sediment accumulating in the Columbia River channel for each alternative under both the base and with-project conditions. These costs are likewise expressed in equal annual amounts. The difference in costs between the base condition and with-project condition for each alternative structure represents the benefit or dollar savings each year for each alternative.

Average annual flood control benefits are directly related to the volume of sediment removed and subsequent impact on water surface elevations in the Cowlitz River. Based upon the total amount of sediment movement projected and the annual rate of delivery to Cowlitz River, benefits for flood damage prevention are computed both for the base condition and for each alternative plan of the with-project condition.

The analysis uses the following procedure in measuring flood control benefits. It applies stage-damage analysis to leveed and unleveed areas from the Cowlitz River mouth to the confluence of the Cowlitz and Toutle Rivers to measure potential damages for a range of flood events. It delineates by type, location, and ground floor elevation, all improvements in the flood plain. The value of structures and contents are determined from tax assessment records, valuation formulae applied to contents, or individual appraisals. Depth-damage data from the Federal Insurance Administration and depth-damage relationships developed for Portland District by an engineering consulting firm supply the base for computing damages at various flood levels. The hydrology component of the analysis assumed normal water year conditions.

The next step of the analysis develops stage-damage curves for 8 subreaches along the lower 25 miles of the Cowlitz River, including I-5 and BNRR bridges, highway and rail lines. Data from the stage-damage curves are then integrated with stage frequency curves having a probability of occurrence ranging from annual (.95 probability) to 1 in 500 years (.002). Appendix E presents the

stage-damage methodology in detail. The analysis measures flood damages in constant dollars. In fact, all costs and benefits in this report reflect current 1984 dollars. For purposes of discounting costs and benefits incurred in future years, the current Federal interest rate of 8-1/8 percent is applied.

Flood control benefits developed for each SRS alternative using the above method are somewhat understated in that no credit is given for the capability of SRS to reduce flood peaks during the early life of the project. Some reduction in flood peaks would be accomplished by storing floodwaters, allowing the settlement of material. The large SRS have greater storage capability and consequently would realize more of these incidental benefits. Furthermore, implementation costs associated with temporary evacuation measures are not included in residual damage estimates under the base condition. Moreover, the costs resulting from disruption of waterborne commerce on the Columbia River channel have not been included.

Given the criteria outlined above and based upon evaluation of the data in this study, the NED solution is a single retention structure 177 feet high at the Green River site. This plan is selected for the following reasons: (a) it best meets the requirements of national economic development, yielding the greatest net benefits of all plans considered; and (b) it also has the physical capability to contain most of the material projected to be carried into the Cowlitz and Columbia Rivers over the 50-year project life. It also would cause the least disruption of the physical environment and related resources.

Of the alternative sites and various spillway height elevations considered, the SRS at Green River provides the most effective and efficient solution, given the total volume of material and rate of infill anticipated over a 50-year period. Chapter V describes the physical details of the structure. Until completed, interim annual dredging of sediment from the Cowlitz River would continue, maintaining existing channel capacity and level of flood protection in conformance with PL 98-63 (base condition).

The impact of the preferred plan on sediment movement is summarized in table IV-3 and described in detail in appendix D. By trapping 299 mcy of sediment behind the SRS, the dredging requirements are reduced to 44 mcy from 184 mcy under the base condition. The reduction in sediment entering the Cowlitz River will cause erosion of the existing sediments and result in lower water surface elevations at Castle Rock and Longview-Kelso as shown on figures IV-3 and IV-4.

TABLE IV-3

PREFERRED ALTERNATIVE SEDIMENT MOVEMENT

(MCY)

50-Year Project Life

1985 - 2035

ESTIMATED AVALANCHE EROSION		
	750	TOTAL EROSION BY 2035
	-99	PREVIOUSLY ERODED
	651	TOTAL 50-Year EROSION
TOUTLE RIVER		
	651	YIELD TO
	+23	EROSION
	-328	DEPOSITION (299 SRS RETENTION* + 29 DREDGING)
COWLITZ RIVER		
	346	Yield to
	+10	Erosion
	0	DEPOSITION
COLUMBIA RIVER		
	356	YIELD TO
	0	EROSION
	-15	DEPOSITION (TO BE DREDGED)
	341	TO MOVE THROUGH COLUMBIA RIVER
TOTAL DREDGING REQUIRED	44	

* - ASSUMES OPERATION EFFECTIVENESS 1987

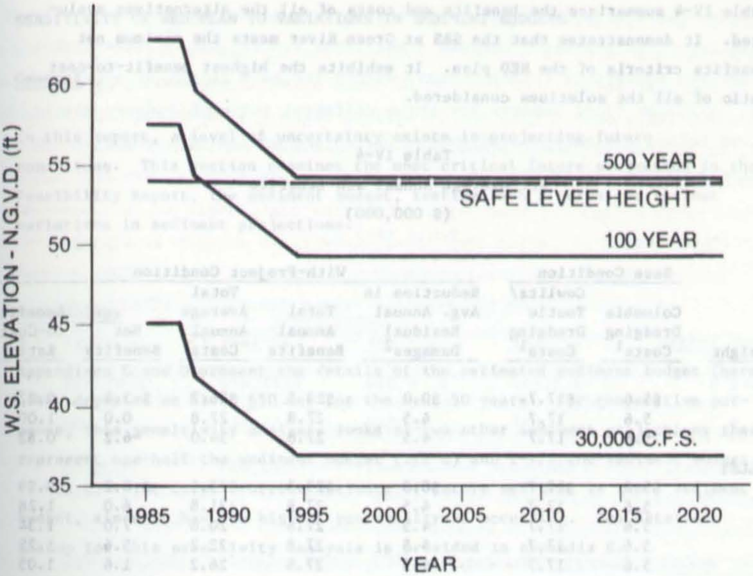


Figure IV-3. Water surface elevation for NED plan at Castle Rock (RM 17.6).

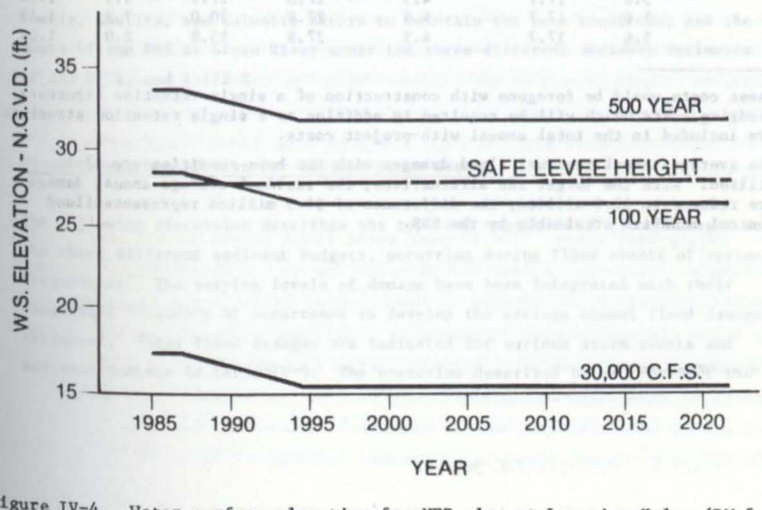


Figure IV-4. Water surface elevation for NED plan at Longview-Kelso (RM 5.5).

Table IV-4 summarizes the benefits and costs of all the alternatives evaluated. It demonstrates that the SRS at Green River meets the maximum net benefits criteria of the NED plan. It exhibits the highest benefit-to-cost ratio of all the solutions considered.

Table IV-4

Net Average Annual NED Benefits

($ 000,000)

Site/Height	Base Condition: Columbia Dredging Costs[1]	Base Condition: Cowlitz/ Toutle Dredging Costs[1]	With-Project Condition: Reduction in Avg. Annual Residual Damages[2]	With-Project Condition: Total Annual Benefits	With-Project Condition: Total Average Annual Costs	With-Project Condition: Net Benefits	With-Project Condition: Benefit-to-Cost Ratio
LT-3							
107	$5.6	$17.7	$0.0	$23.3	$26.7	$-3.4	0.87
132	5.6	17.7	4.5	27.8	27.8	0.0	1.00
162	5.6	17.7	4.5	27.8	34.0	-6.2	0.82
KID VALLEY							
118	$5.6	$17.7	$0.0	$23.3	$23.5	$-0.2	0.99
163	5.6	17.7	4.5	27.8	21.8	6.0	1.28
208	5.6	17.7	4.5	27.8	20.8	7.0	1.34
243	5.6	17.7	4.5	27.8	22.2	5.6	1.25
318	5.6	17.7	4.5	27.8	26.2	1.6	1.05
GREEN RIVER							
77	$5.6	$17.7	$0.0	$23.3	$23.9	$-0.6	0.97
112	5.6	17.7	4.5	27.8	20.3	7.5	1.37
142	5.6	17.7	4.5	27.8	18.0	9.8	1.54
177	5.6	17.7	4.5	27.8	17.9	9.9	1.55
202	5.6	17.7	4.5	27.8	20.0	7.8	1.39
272	5.6	17.7	4.5	27.8	25.8	2.0	1.08

1. These costs would be foregone with construction of a single retention structure. Dredging costs which will be required in addition to a single retention structure are included in the total annual with-project costs.

2. The average annual residual flood damages with the base condition are $7.1 million. With the larger SRS alternatives, the residual average annual damages are reduced to $2.6 million; the difference of $4.5 million represents flood control benefits attainable by the SRS.

SENSITIVITY OF NED PLAN TO VARIATIONS IN SEDIMENT BUDGETS

General

In this report, a level of uncertainty exists in projecting future conditions. This section examines the most critical future projection in the Feasibility Report, the sediment budget, testing each alternative against variations in sediment projections.

Methodology

Appendixes C and D present the details of the estimated sediment budget (hereafter depicted as E) of 650 mcy for the next 50 years. For comparative purposes, this sensitivity analysis looks at two other sediment projections that represent one-half the sediment budget (1/2 E) and 1-1/2 the sediment budget (1-1/2 E). The Corps' current estimate of future sediment is the E sediment budget, since it has the highest probability of occurring. The detailed backup for this sensitivity analysis is provided in appendix E.

This section examines the consequences for a chosen alternative when assuming one budget and a different one actually occurs. The section describes the residual average annual flood damages and cost of continued dredging on the Toutle, Cowlitz, and Columbia Rivers to maintain the base condition; and the costs of the SRS at Green River under the three different sediment estimates of 1/2 E, E, and 1-1/2 E.

Flood Damage Description for Various Storm Events

The following discussion describes the type and magnitude of flood damages for the three different sediment budgets, occurring during flood events of various frequencies. The varying levels of damage have been integrated with their respective frequency of occurrence to develop the average annual flood damage estimates. Total flood damages are indicated for various storm events and sediment budgets in table IV-5. The scenarios described below represent the

single occurrence of a flood event and its impact, given the base condition of the existing river channel. Damages result from the failure of levees when water surface elevations (river stages) exceed the safe height of each levee system. Although flood damages for three different sediment budgets are described below, the anticipated budget (E) is the only budget supported by extensive modeling and research.

Table IV-5
Total Flood Damages
($000)

Sediment Budget	Storm Event 10-Year	20-Year	50-Year	100-Year
1/2 E	$ 3,667	$ 4,310	$121,012	$161,350
E	4,121	35,580	154,649	177,700
1-1/2 E	35,015	121,442	163,800	202,675

One-half Budget. Damages for the following events would be incurred given one-half the anticipated budget.

a. Ten-Year Event. The ten-year event flood levels would not exceed safe height at any of the four leveed areas (Longview, Kelso, Lexington, and Castle Rock). Transportation facilities (major highways and bridges) would not suffer damages. Flood losses in the unleveed areas of the flood plain would arise mostly from farms, residential improvements, and Castle Rock High School. Total estimated flood damages for a 10-year flood event are $3,667,000.

b. Twenty-Year Event. The 20-year event flood levels do not exceed safe levee height at any of the four leveed areas and do not damage major transportation facilities. Flood damages to the unleveed areas of the flood plain, mostly farms and residential improvements, would amount to $4,310,000, including damages to Castle Rock High School. Total estimated flood damages for the 20-year flood event are $4,310,000.

c. Fifty-Year Event. With one-half the sediment delivery, the 50-year event flood levels exceed the safe heights of levees at Kelso and Castle Rock. Estimated flood damages at Kelso would be $85,000,000, including those to residential improvements, a major portion of the city's commercial district, and the entire industrial park. Castle Rock would incur $31,000,000 in flood damages, and the unleveed areas of the flood plain would experience $5,010,000 in damages. Major highway and railroad bridges near the Toutle River mouth would incur flood damages of $2,000. Levee safe height at Longview and Lexington would not be exceeded. Total estimated flood damages for the 50-year event with a one-half budget are $121,012,000.

d. One Hundred-Year Event. The 100-year event would exceed the safe height of all existing levees except Longview. Kelso would experience $88,000,000 in damages. Lexington would incur $35,000,000 in damages, and Castle Rock, $32,200,000. Unleveed flood plain lands would have damages of $5,980,000, and highways, railroads, and bridges comprising the transportation corridor would experience estimated flood damages of $170,000. Total estimated flood damages resulting from a 100-year event are $161,350,000.

Estimated Budget. Damages for the following events would be incurred under the anticipated sediment volume.

a. Ten-Year Event. The ten-year event flood levels do not exceed safe height at any of the four leveed areas (Longview, Kelso, Lexington, and Castle Rock). Flood damages in the unleveed areas of the flood plain would affect mostly farms, residential improvements, and Castle Rock High School. The transportation corridor is not affected by the 10-year event. Total estimated flood damages for a 10-year flood event are $4,121,000.

b. Twenty-Year Event. The 20-year event flood levels do not exceed safe levee height at Longview, Kelso, or Lexington, and do not damage major transportation facilities. The Castle Rock levee safe height is exceeded, and estimated damages of $30,800,000 would occur. The major portion of this city would be inundated, flooding residential and commercial properties. Castle Rock has no industrial area. Flood damages to the unleveed areas in the flood plain, mostly farms and residential improvements, would amount to $4,780,000,

including damage to Castle Rock High School. Total estimated flood damages for the 20-year flood event are $35,580,000.

c. Fifty-Year Event. The 50-year event flood levels exceed the safe heights of levees at Kelso, Lexington, and Castle Rock. Estimated flood damages at Kelso would be $86,200,000, including residential improvements, a major portion of the city's commercial district, and the entire industrial park. Damages at Lexington, amounting to $30,800,000, mostly concern residential properties but include a large BPA electric substation. Castle Rock would experience $32,000,000 in damages, an increase of less than 4 percent from the 20-year event. The unleveed area in the flood plain would experience $5,640,000 in damages, an increase of about 18 percent over those of the 20-year event. Major highway and railroad bridges near the Toutle River mouth would incur flood damages of $9,000. The levee safe height at Longview would not be exceeded. Total estimated flood damages for the 50-year event are $154,649,000.

d. One Hundred-Year Event. The 100-year event would exceed the safe height of all existing levees. Longview would experience an estimated $9,400,000 in flood damages. This amount is relatively small (less than 0.5 percent) compared to the damage potential ($1.3 billion) of this city. The damages would occur mostly to residential and suburban-type commercial enterprises located at low elevations within the Longview Diking District. Kelso would have $89,700,000 in damages, an increase of about 4 percent from the 50-year event. Lexington would undergo $37,500,000 in damages, an increase of about 22 percent beyond the 50-year event. Castle Rock would incur about $33,000,000, an increase of about 4 percent over the 50-year event. Unleveed flood plain lands would receive damages of $6,970,000, an increase of about 23 percent; while highways, railroads, and bridges comprising the transportation corridor would experience estimated flood damages of $1,200,000, an increase of 133 percent from 50-year flood levels. Total estimated flood damages resulting from a 100-year event are $177,700,000.

One and One-half Budget. Damages for the following events would be incurred in the event that sediment volume delivered was 50 percent greater than the amount anticipated.

a. Ten-Year Event. The ten-year event flood levels do not exceed safe height at three leveed areas: Longview, Kelso, and Lexington. The levee safe height at Castle Rock is exceeded and estimated flood damages of $30,500,000 would occur. Inundation of leveed areas of the flood plain will damage residential improvements and farms in these areas, including the high school at Castle Rock. The transportation corridor is not affected by the 10-year event. Total estimated flood damages for a ten-year flood event are $35,015,000.

b. Twenty-Year Event. The 20-year event flood levels do not exceed safe levee heights at Longview and Lexington and would cause only minor damage to transportation facilities. The safe heights of Kelso and Castle Rock levees are exceeded, resulting in $84,000,000 and $32,000,000 damages, respectively, to those communities. Major portions of these cities would be inundated, causing damage to residential and commercial properties. Damages to unleveed areas would amount to $5,442,000. Total estimated flood damages for a 20-year flood event would be $121,442,000.

c. Fifty-Year Event. The 50-year event flood levels exceed the safe heights of levees at Kelso, Lexington, and Castle Rock. Estimated flood damages at Kelso would be $88,000,000, including residential improvements, a major portion of the city's commercial district, and the entire industrial park. Damages at Lexington, amounting to $33,000,000, mostly concern residential properties but include a large BPA electric substation. Castle Rock would experience $33,000,000 in damages. The unleveed area of the flood plain would experience $9,740,000 in damages. Major highway and railroad bridges near the Toutle River mouth would incur flood damages of $60,000. Levee safe height at Longview would not be exceeded. Total estimated flood damages for the 50-year event are $163,800,000.

d. One Hundred-Year Event. With a 50 percent greater sediment budget than planned, a 100-year event would exceed the safe height of all existing levees. Longview would experience an estimated $12,500,000 in flood damages. This amount is relatively small (less than 1 percent) compared to the damage potential ($1.3 billion) of this city. The damages would occur mostly to residential and suburban-type commercial enterprises located at low elevations

within the Longview Diking District. Kelso would have $91,000,000 in damages, Lexington would incur $41,000,000 in damages, and Castle Rock would receive about $34,000,000. Unleveed flood plain lands would undergo damages of $10,175,000; and highways, railroads, and bridges comprising the transportation corridor would experience estimated flood damages of $14,000,000. Total estimated flood damages resulting from a 100-year event are $202,675,000.

Summary. While the flood damages from using the 1/2 E budget are lower than those from the E budget, significant damages still occur. The flood damages for 50- and 100-year events with the 1/2 E budget are close to those anticipated for E. In addition, if temporary evacuation of residents in the Cowlitz River flood plain were required, the cost would be $26 million.

Maintenance of the existing temporary structures will provide some benefits. Half of the freeboard can be used to reduce the base condition's residual average annual damages. However, this results in less than a 10 percent reduction. For the temporary structures to be rebuilt to their original condition, some of the existing temporary structures would need removal at a cost of $614,000 and complete replacement at a cost of $2.1 million.

Costs and Residual Flood Damages of Continued Dredging

Continued dredging to maintain the base condition represents a flexible method for dealing with different sediment levels as initial fixed costs are held to a minimum. As different levels of sediment migrate through the river system, they are dealt with to the extent practicable. The average annual cost (AAC) of the dredging alternative for 1/2 E are $8.0 million, for E the AAC are $23.3 million, and for 1-1/2 E the AAC are $46.9 million.

The different levels of sediment deposition in the Cowlitz River associated with 1/2 E and 1-1/2 E will result in different residual average annual flood damages (AAD) than those shown in appendix E. The dredging alternative will maintain a greater level of flood protection when less sediment enters the Cowlitz. The AAD for the dredging alternative with 1/2 E are $3.6 million, with E the damages are $7.1 million, and with 1-1/2 E they are $9.8 million.

Costs and Residual Flood Damages for Green River SRS

The costs for a Green River SRS and the associated downstream measures vary with projected sediment budgets. Assuming a budget of E, the SRS with the highest net benefits would be at Green River with a height of 177 feet. If the 177-foot SRS is constructed, variation in downstream costs will occur with different sediment budgets. The average annual costs of the 177-foot SRS plan and downstream measures for 1/2 E are $13.3 million, for E the AAC are $17.9 million, and at 1-1/2 E, AAC are $27.8 million.

If, however, a budget different from E is projected to occur, then the best SRS plan would be at a different height than 177 feet. For example, if 1/2 E is expected, the plan with the highest net benefits would be an SRS at Green River of 112 feet, while an SRS at Green River of 202 feet would be the best plan with an expected budget of 1-1/2 E. Here again the total plan costs will vary with different actual budgets because of downstream action costs. The table below summarizes the different AAC of SRS alternative with the different sediment budgets.

Table IV-6
Average Annual Costs
($ 000,000)

Actual Budgets	Green River SRS 112 feet		Green River SRS 177 feet		Green River SRS 202 feet	
	Structure	D/S Actions	Structure	D/S Actions	Structure	D/S Actions
With 1/2 E	8.0	3.3	11.2	2.1	13.4	2.0
With E	8.0	12.3	11.2	6.7	13.4	6.6
With 1-1/2 E	8.0	31.0	11.2	16.6	13.4	11.0

The residual average annual damages with the SRS are $2.4 million for 1/2 E, $2.6 million with E. With the 1-1/2 E budget, the AAD are $8.7, $7.0, and $4.7 million for the three different sized SRS's. The variation in AAD stems from how fast the structure fills in with sediment.

Comparison of Dredging and SRS

Table IV-7 presents the results of the sensitivity analysis. This matrix shows the nine possible combinations of structure design for one of three sediment budgets (1/2 E, E, 1-1/2 E) and the resulting costs and damages of actually incurring one of the three budgets. As stated above, if different budgets are expected, a different height of the Green River SRS would be required. That is, if more sediment were expected, a higher dam would be built. Each block in table IV-7 compares the total AAC and residual average annual flood damages (AAD) for the dredging and Green River SRS alternatives. The center block of this matrix represents the most likely future condition used for evaluation in this feasibility report. By comparing the sum of AAC and AAD in each block, one can identify the total cost to the economy and the least costly alternative under each scenario.

Table IV-7

Sensitivity Matrix

ACTUAL BUDGET			DESIGN FOR: SRS @ 112 ft 1/2 E	SRS @ 177 ft E	SRS @ 202 ft 1-1/2 E
1/2 E	SRS	AAC	11.3	13.3	15.4
		AAD	2.4	2.4	2.4
			13.7	15.7	17.8
	D	AAC	8.0	8.0	8.0
		AAD	3.6	3.6	3.6
			11.6	11.6	11.6
E	SRS	AAC	20.3	17.9	20.0
		AAD	2.6	2.6	2.6
			22.9	20.5	22.6
	D	AAC	23.3	23.3	23.3
		AAD	7.1	7.1	7.1
			30.4	30.4	30.4
1-1/2 E	SRS	AAC	39.0	27.8	24.4
		AAD	8.7	7.0	4.7
			47.7	34.8	29.1
	D	AAC	46.9	46.9	46.9
		AAD	9.8	9.8	9.8
			56.7	56.7	56.7

In all cases, if the 1/2 E budget actually occurs, then the dredging alternative represents the least cost plan. Alternatively, if E or 1-1/2 E budgets actually occur, the Green River SRS alternative is less costly than dredging for the three different sized SRS.

Another approach to the sensitivity examines the consequences of committing to an alternative based on an expected budget and then incurring a different budget. Since the best estimate of sediment movement is E, the following discussion examines the consequences of designing for this budget.

If the SRS of 177 feet is constructed in anticipation of the E budget and the 1/2 E budget occurs instead, the sum of AAC and AAD for dredging would be \$11.6 million or \$4.1 million less than the SRS costs and damages of \$15.7 million. However, if the E budget actually occurs, then the 177-foot SRS plan would represent a cost and damage saving of \$9.9 million (\$30.4 - \$20.5 million) over dredging. Finally, if the 177-foot SRS is constructed and the 1-1/2 E budget occurs, then the SRS would have a cost and damage advantage of \$21.9 million (\$56.7 million - \$34.8 million) over the dredging alternative.

The breakeven point for the percentage of the sediment budget that would have to occur to produce the same costs for dredging and SRS is shown on figures IV-5 through IV-7 for each design scenario. Figure IV-6 shows that if the 177-foot SRS were built, it would have less costs and damages than dredging as long as 0.65 E, or volume in excess of 0.65 E occurs.

Conclusion of the Sediment Budget Sensitivity Analysis

If the NED plan discussed in this report were built in anticipation of the E budget, and 1/2 E actually occurs, then the least costly alternative was not chosen. However, if the NED plan were built and 0.65 E, or something greater actually occurs, then the NED plan represents a less costly alternative than long-term dredging.

Risk Analysis - Extreme Events

General. The first component of the sensitivity analysis demonstrated the relative advantages of the Green River SRS and continued dredging alternatives for different levels of sediment movement. The sensitivity analysis concentrated upon each plan's effectiveness in dealing with projected average annual movement of sediment. As explained in appendix C, movement of sediment over time is expected to vary widely from the average annual condition. The remainder of this sensitivity section describes

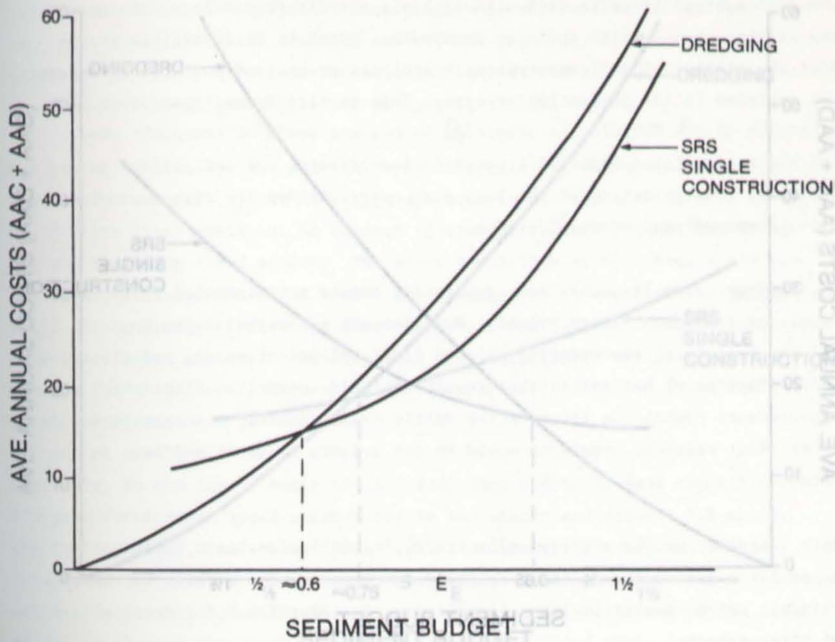


Figure IV-5. Structures Designed for ½E

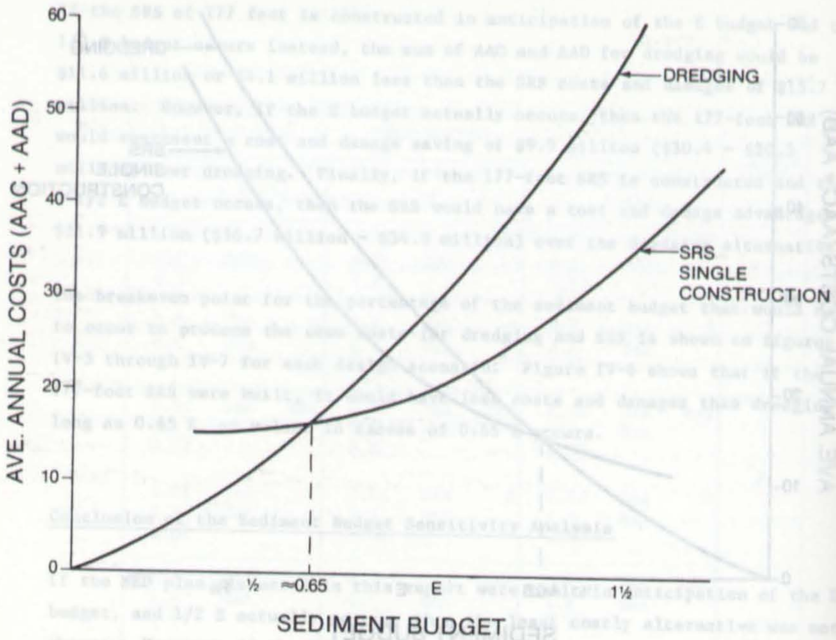


Figure IV-6. Structures Designed for E

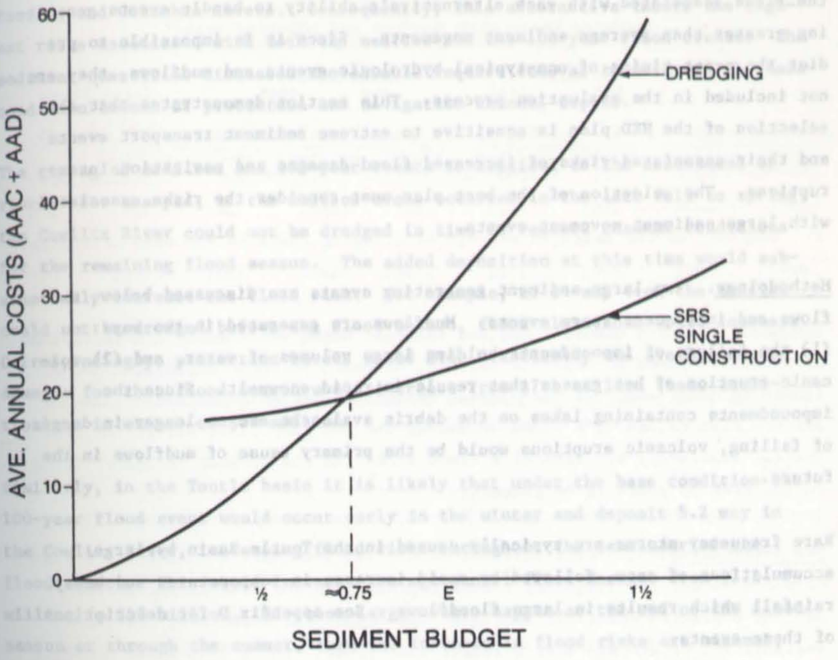


Figure IV-7. Structures Designed for 1½E

the risks associated with each alternative's ability to handle events generating greater than average sediment movements. Since it is impossible to predict the exact timing of non-typical hydrologic events and mudflows, they are not included in the evaluation process. This section demonstrates that the selection of the NED plan is sensitive to extreme sediment transport events and their associated risks of increased flood damages and navigation interruptions. The selection of the best plan must consider the risks associated with large sediment movement events.

Methodology. Two large sediment generating events are discussed below, mudflows and infrequent storm events. Mudflows are generated in two ways: (1) the failure of impoundments holding large volumes of water, and (2) volcanic eruption of hot gasses that result in rapid snowmelt. Since the impoundments containing lakes on the debris avalanche are no longer in danger of failing, volcanic eruptions would be the primary cause of mudflows in the future.

Rare frequency storms are typically caused in the Toutle Basin by large accumulations of snow, followed by rapid increase in temperatures and heavy rainfall which results in large floodflows. See appendix D for descriptions of these events.

Because of the large supply of material available in the debris avalanche, the magnitude of sediment movement for the mudflow and 100-year events remains constant over the 50-year period of analysis. Also, the sediment magnitude of each event is the same under the 1/2 E, E, and 1-1/2 E budgets. As discussed in appendix D, the mudflow event evaluated here is 75 mcy in the upper North Fork of the Toutle River. It is estimated that this event would deposit 14 mcy of sand in the Cowlitz River and 6 mcy in the Columbia navigation channel. Under the no-action condition, the 100-year flood event will deposit 3.6 mcy in the Cowlitz River and 6.7 mcy in the Columbia navigation channel. The risks associated with these two extreme events are evaluated below for both the base condition (dredging) and SRS using different sediment budgets.

Base Condition (Continued Dredging). The dredging alternative constitutes a reactive plan, since it removes sediment that has settled in the Cowlitz,

Toutle, and Columbia Rivers. Consequently, this alternative incurs the highest risks associated with both the mudflow and the 100-year flood events. The sediment quantities discussed above would require removal to maintain the base condition levels of protection and navigation channel depths.

The timing of mudflows and 100-year events is critical to the assessment of risks. For example, if the mudflow event occurred in the late fall to spring, the Cowlitz River could not be dredged in time to restore channel conditions for the remaining flood season. The added deposition at this time would substantially increase the flood risk. For example, if 14 mcy from the mudflow could not be dredged before the flood season, flood elevations would increase. Correspondingly, protection levels would drop drastically and average annual damages for that flood season would increase from $7.1 million (base condition) to in excess of $80 million.

Similarly, in the Toutle basin it is likely that under the base condition the 100-year flood event would occur early in the winter and deposit 5.2 mcy in the Cowlitz River, increasing flood risks throughout the remainder of the flood season. This would increase average annual flood damages from $7.1 million to $13 million. If these large events happen at the end of the flood season or through the summer, then the increase in flood risks are minimal, provided the material is removed prior to the following winter. However, the risks associated with interruptions to navigation in the Columbia River caused by the 5.1 mcy deposition remain essentially the same throughout the year.

The costs of removing this material would increase over time as the least expensive disposal sites are filled in. Using a weighted average of the per-unit dredging costs over the next 50 years, the expense of dredging materials from the mudflow and 100-year flood to restore the base condition are shown below.

Table IV-8

Dredging Costs with Mudflow and 100-Year Event[1]

	Columbia mcy	Columbia cost	Cowlitz mcy	Cowlitz cost	Total Costs
Mudflow	6	$18,600,000	14	$49,000,000	$67,000,000
100-year Event	5.1	$15,800,000	5.2	$18,200,000	$34,000,000

1. Computed as the weighted average of dredging costs in the base condition.

The years in which the mudflows and 100-year event would occur are impossible to predict. Based on historic records, however, volcanic activity is more likely to occur early in the 50-year evaluation period than later. Also, a 40 percent risk exists of a flood exceeding the 100-year flood within the next 50 years. Similarly, the risk of a flood exceeding the 50-year frequency flood in the next 50 years is 64 percent.

SRS Alternative. The effectiveness of the SRS alternative in storing sediment of mudflows and low frequency floods depends upon the size of the structure and the available reservoir storage. The higher the structure, the greater availability of storage over a longer time frame. Table IV-9 shows how long each of the four different-sized SRS alternatives would have adequate storage capacity to accommodate the entire 75-mcy mudflow and/or the 100-year flood event. This table assumes average annual sediment movement up to the dates shown.

Table IV-9

Years in Which SRS Alternatives Are No Longer Effective in Storing Mudflows and 100-Year Events[1]

	77-foot		112-foot		177-foot		202-foot	
	Mudflow	100-Yr	Mudflow	100-Yr	Mudflow	100-Yr	Mudflow	100-Yr
1/2 E	1987	1987	1988+	1988+	1993	2002	2004	2022
E	1987	1987	1988+	1988+	1991	1995	1994	1999
1-1/2 E	1987	1987	1988+	1988+	1989	1991	1991	1994

1. Assumes that average annual inflow of sediment occurs up to this date and the mudflows or 100-year events occur in the years shown.

Figure IV-8 graphically presents the 100-year flood event. As the plot of the 1/2 E budget shows, for every 10 feet of structure height beyond 177 feet, the capacity to handle the 100-year flood is extended an additional 8 years. In contrast, for every 10 feet of dam height up to 112 feet, less than 1 year of effectiveness is added. The slope of the lines in figure IV-8 define the marginal reduction in risks associated with the rare events due to changes in structure heights.

These curves demonstrate that with the 1/2 E budget, structures in excess of 142 feet are the most efficient for dealing with rare events. Although relative advantages are not as well defined for the E and 1-1/2 E budgets, it appears that structure heights in excess of 160 feet (for E) and 190 feet (for 1-1/2 E) are more efficient for handling the 100-year flood event. These same general conclusions hold for the mudflow event.

The risk of flooding and navigation interruption associated with the mudflow and 100-year event are nil up to the time described in table IV-9. After these effective dates, the SRS will lose its capacity to trap the entire sediment movement; and flooding risks will eventually increase to the levels of the dredging alternative. Each structure will, however, be able to partially

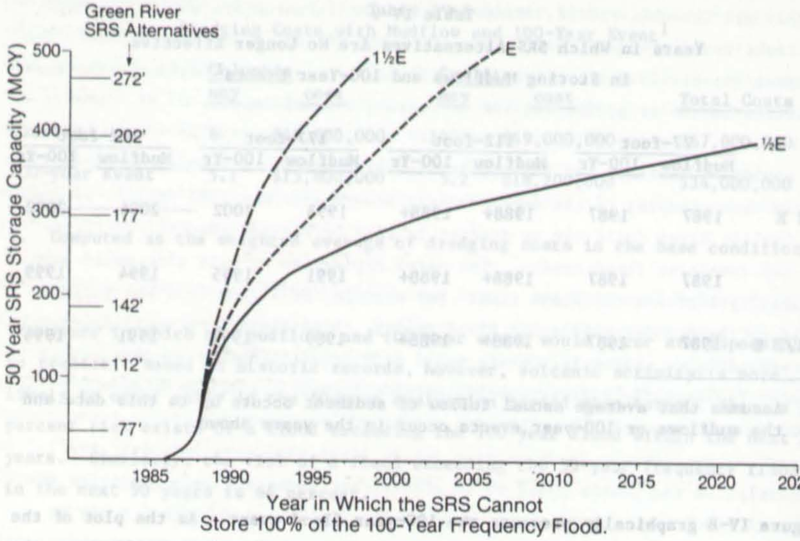


Figure IV-8. 100-Year Flood Event

reduce sediment movements after the dates shown in table IV-9. One other inherent advantage of the SRS alternative over the base condition is that during the years in which the SRS is efficiently storing material, the Cowlitz River streamflow will act to scour out sediments. This will increase channel capacity and produce a higher level of protection in the Cowlitz. Therefore, when the SRS is no longer able to contain the mudflow or a large flood event, any subsequent deposition in the Cowlitz River would result in a smaller increase in average annual damages than provided by the dredging alternative. Furthermore, with the SRS, the amount of dredging in the Cowlitz, Toutle, and Columbia Rivers is much smaller than with the base condition; and the less expensive dredge disposal sites are not exhausted as rapidly. As such, the per-unit costs for required dredging after a mudflow or 100-year flood would be less with the SRS alternative than under the base condition.

Summary of Dredging and SRS Comparison. The SRS alternatives substantially reduce risks of increased flood damages and navigation interruptions due to large mudflow events and rare frequency floods. The size of the structure determines how many years the SRS will be able to store these large events. For example, with the estimated budget (E) the 77-foot-high SRS will be able to completely accommodate the 100-year event only until 1987, while the 202-foot-high SRS will be effective until 1999. If the large events occur within the SRS effective time frames, downstream impacts are significantly reduced by the structure and a substantial reduction in risks is realized, compared to the dredging alternative.

With the dredging alternative, a design mudflow event would cause substantial flood damage and also clog the Cowlitz River channel. If this sediment deposition in the Cowlitz could not be removed before the flood season, the potential average annual damages (AAD) would increase by about $72.9 million. The costs of removing the sediment deposited by a mudflow event is $49 million in the Cowlitz and $18.6 million in the Columbia River. None of these costs will be incurred if the SRS has capacity to completely store the event. Similar findings occur with the 100-year event. Even when the storage capacity of the SRS alternative has been reduced to a level that cannot completely contain the large events, the SRS alternative would continue to provide advantages over the dredging alternative. These advantages include: (1) partial containment of large event

sediments, (2) less average annual flood damages because of scouring in the Cowlitz River up to the date of the rare event, and (3) reduced per-unit dredging costs of both the Cowlitz and Columbia Rivers.

Sensitivity of Sizing of SRS to Handle Large Events. The ability of any SRS to handle a large influx of sediment from mudflows and rare floods diminishes over time as the structure fills with sediment. Figure IV-8 shows, for the range of sediment budgets, the years in which the different sized SRS lose their capacity to store the entire sediment amounts generated by a large event.

The slopes of the curves in figure IV-8 demonstrate the marginal changes in the ability to store mudflows and rare flood events based on SRS heights. The flatter portions of the curves represent the range of SRS heights in which each additional foot of structure substantially reduces the downstream risks from mudflows and the 100-year event.

If the 1/2 E budget occurs, any SRS higher than 142 feet provides definite advantages over the lower structures in terms of reducing risks associated with rare events. Consequently, if the projected budget were 1/2 E, selection of a preferred plan would be sensitive to accounting for the risks of mudflows or rare flood events. As stated earlier in this chapter, the best plan with a 1/2 E budget is 112 feet high. But, based on this risk analysis the preferred plan would be a project in excess of 142-foot height.

For the estimated budgets E and 1-1/2 E, selection of the preferred plan does not appear to be sensitive to the risks associated with rare events. That is, the changes in risks for deviating from the NED plan are minimal and do not warrant building a higher structure. With the estimated sediment budget (E) the NED plan is a 177-foot-high structure able to store the entire 100-year event up to year 1995. By constructing the next highest structure of 202 feet, 4 more years are added to the structure's ability to handle a 100-year event. Since it is impossible to determine when the 100-year flood or mudflow would occur, the economic value of 4 more years of protection could not be established. The incremental structure cost for a 177-foot to 202-foot structure raise is in excess of $30 million and is not warranted by the indeterminant reduction in risks.

<u>Conclusion</u>. For the estimated budget (E), the selection of a plan other than the NED plan is not sensitive to considerations of rare mudflow or flood events. If 1-1/2 E budget were expected, the 202-foot-high NED plan provides a reasonable degree of protection from rare flood events. However, if the 1/2 E budget were expected, the NED plan would be a 112-foot-high structure accommodating mudflows and 100-year events only until 1987. With 1/2 E, a 177-foot structure could accommodate a 100-year event until 2002. Consequently, the selection of a preferred plan may be sensitive to mudflows and rare flood events if the 1/2 E budget is expected.

CHAPTER V - THE PREFERRED PLAN

OVERVIEW

Chapters II through IV presented the formulation process used to develop the NED plan. This chapter discusses the factors considered in identifying the preferred plan, describes the elements of the plan, outlines anticipated direct and indirect benefits, and summarizes total costs and benefits.

The NED plan, a 177-foot structure at Green River, was selected because it is $117 million less than its nearest competitor. a 142-foot structure at the same location. The principles and guidelines used for Federal studies require designation of the NED plan as the preferred plan unless overwhelming evidence justifies another selection. This report examines factors beyond the benefits attributable to impacts on the average annual sediment projections.

The structure should contain either a design mudflow of 75 mcy or the sediment delivered by a 100-year event in the first years of the life of the project. Since the early years are the most susceptible to risks created by large sediment movement, no additional provisions are considered necessary for the project. As sediment deliveries decrease with time, significant risks created by large events are reduced. Should revised long-term projections indicate an increase in sediment delivery over projected quantities, provisions can be made to raise the structure.

As the discussion on the sensitivity of the NED plan notes, the 177-foot structure provides, during the first years of its life, enough capacity to contain either a design mudflow or the sediment delivered by a 100-year event. The 177-foot structure provides approximately 100 mcy more storage over its 50-year life than does the 142-foot structure. This additional storage allows the 177-foot structure to capture sediment from extreme events longer than the 142-foot structure and at a lower total cost.

The operation of the 177-foot structure was tested for both the 100-year flood and the design mudflow to compare to the with-project and without-project

conditions. Routing of the 100-year flood shows that conditions will not be worsened at either the structure site or at downstream damage centers. Construction of the structure will not worsen the effects of the design mudflow at the structure or immediately downstream. Effects of the structure on the mudflow peak and duration at downstream damage centers has not been fully evaluated.

During public and agency review of the Comprehensive Plan, Washington State, local governments and various resource agencies supported a single retention structure upstream of the Green River confluence with North Fork Toutle River. Reasons for the selection of this alternative included upstream sediment trapping and minimum impact to the fishery, land use and residents. The NED plan fulfills the desires of these important groups (see chapter VIII).

Briefly, the preferred plan consists of a single retention structure at the Green River site as shown on figure V-1, downstream dredging and some levee reinforcement. This plan fulfills the primary objectives of reducing flood hazards at communities along the lower Cowlitz River while reducing dredging requirements in the Columbia River navigation channel. In its combination of elements, the plan offers maximum flexibility to respond to changing conditions in the unstable Toutle River Basin environment caused by eruptions of Mount St. Helens. The plan also incorporates the recommendations of Cowlitz County's Toutle-Cowlitz Watershed Management Plan which advocates measures to block sediment upstream and recommends remedial actions to prevent flooding anticipated before implementation of long-term actions. The Corps' preferred plan would prevent sediment and debris from moving downstream, while the dredging would remove material already in the system or that moves through the Toutle River during construction of the SRS.

PREFERRED PLAN ELEMENTS

The Single Retention Structure

Description. The design and construction methods employed for this structure reflect normal dam design criteria and will address safety and operational

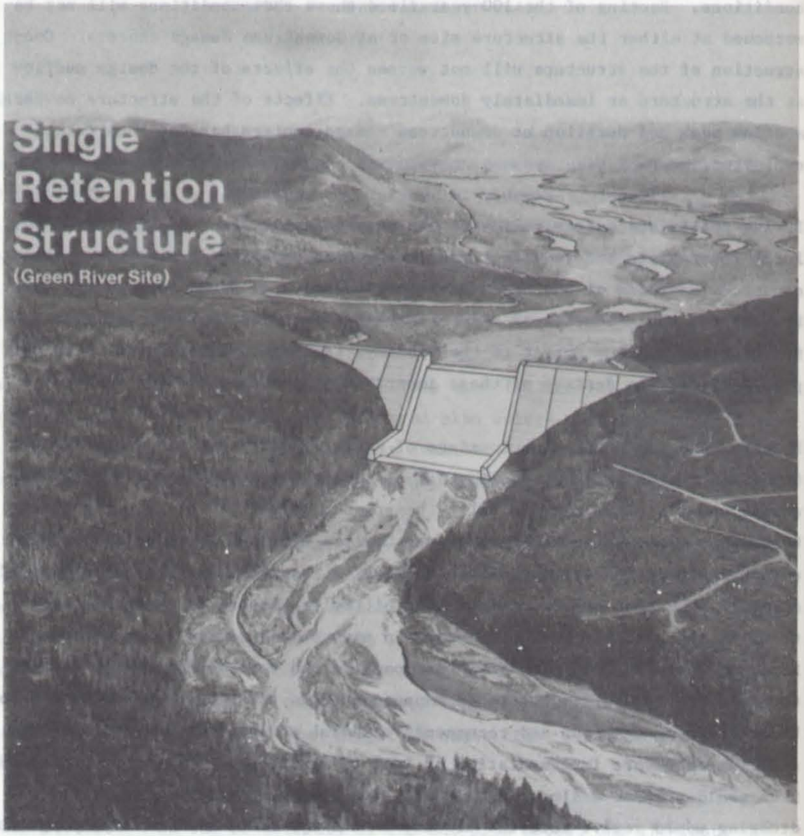


Figure V-1. SRS at Green River site.

characteristics. The dam would be a roller compacted concrete structure built on the North Fork Toutle River at RM 13, just above the mouth of the Green River. It would trap sediment and debris while allowing water to pass through an outlet works or over a spillway. When completed, the dam would rise 315 feet high above foundation grade or 177 feet above existing ground and extend 4,400 feet in length, with a spillway 600 feet wide. Ultimate sediment storage capacity would be 411 mcy, sufficient to retain the 299 mcy of material anticipated to deposit during the project life of 50 years.

Several alternative dam designs could achieve the desired end result. Final choice of design will be made during the detailed design phase.

The first feature constructed under the plan would be a large cofferdam upstream of the damsite and the right abutment outlet works. The cofferdam would serve two purposes. First, it would divert river flows around the work site; and secondly, it would serve as a small interim sediment retention structure. Retention of sediment behind the cofferdam at the earliest possible date will significantly reduce downstream actions. Once the main structure is constructed to a functional elevation higher than the cofferdam, the cofferdam will be abandoned in place in the impoundment area behind the main structure.

The main spillway would be built 155 feet above the existing streambed. Given normal hydrologic conditions, this height will create capacity adequate to capture nearly all problem-causing sediment debris anticipated to erode from the debris avalanche between 1987 and 2001. In addition, this structure provides enough storage and retention capability for sediment yielded during a 100-year flood until 1995. It has similar capability for a design mudflow until 1991. Using outlet works in the structure permits varying the size and depth of the pool extending upstream behind the structure to retain sediment produced during various storm events. During a major storm, a large pool would form, allowing more material to settle out prior to reaching the structure and outlet works.

The structure in its present design not only retains sediment but also provides limited flow control through a notched spillway or a regulating outlet.

However, flow control declines over time as the pool fills and is considered incidental to the structure with no benefits claimed.

Design of the Structure. Initial engineering activities would focus on design of the structure to trap sediment. Assuming receipt of design funds for fiscal year (FY) 1985, (October 1984 through September 1985), design work could be done during FY 1985 so that construction on the cofferdam and outlet works could be initiated in 1986 and completed in 1987.

a. Preliminary Design of the Structure. Preliminary analysis of the Green River site showed the foundation composed of competent basalt, indicating that it could provide adequate support for the proposed structure. Before carrying forward the design, some additional field surveys and explorations may be necessary. All studies required to satisfy Corps' design standards would be carried out.

A technical appendix summarizing preliminary engineering studies and design is included in appendix D.

b. Sizing of the Spillway. Under normal conditions, a spillway is sized to pass the probable maximum flood (PMF). However, given the instability of the upper Toutle River Basin and the necessity for providing the greatest possible margin of safety, the spillway for the retention structure would be sized to pass a sediment bulked PMF with 5 feet of freeboard during the project life.

The preliminary design assumes that Spirit Lake and other upper basin lakes are stabilized. Therefore, hypothetical lake breakouts have not been used as a basis for sizing the spillway. However, the structure would be designed to withstand overtopping in the event of some major event. This insures that even under these conditions the presence of the structure does not aggravate downstream conditions.

Table V-1 shows the peak discharges at the Green River site for normal annual flows, low frequency floods, and the probable maximum flood.

Table V-1
Peak Discharges For Normal and Possible Flows
At Green River SRS Location

Type of Flow	Peak Discharge (cfs)
Mean Daily Flow	1,254
10-Year Flood	13,900
50-Year Flood	17,700
100-Year Flood	19,600
500-Year Flood	23,700
Probable Maximum Flood (PMF)	107,000
Sediment Bulked PMF	176,000

As the table indicates, the peak discharge for the probable maximum flood is 107,000 cfs. Estimates of the peak discharge for the PMF were increased to include sediment entrainment of 65 percent, resulting in a peak discharge of 176,000 cfs.

As sediment infills behind the structure, detention time is decreased (ultimately a run of river configuration) and an additional height of dam crest may be required as an added safety margin. This would prevent outflanking and overtopping of the structure by the sediment such as occurred at debris retention structure N-1.

c. Stilling Basin. A stilling basin for dissipating the energy generated by the spillway discharges will be built as a feature of the dam. Designed to minimize downstream erosion, the basin will be founded on a layer of select fill placed over the foundation gravels and tied to bedrock with anchors. The physical size of the basin and details of materials and construction will be determined in the design phase of the project.

d. Sizing of the Dam. Over the 50-year project life, the dam eventually could retain 299 mcy of sediment (see appendix D). Initially this material would fan out in the upstream end of the pool behind the structure, eventually

migrating toward the dam. To determine the amount of sediment and the size of dam needed to retain it, required an estimate for the upstream slope of retained sediment. Based upon recommendations from the Corps Waterways Experiment Station staff and experience gained from monitoring DRS N-1, an upstream slope of one-half the natural river grade was used to develop the potential storage availability. A curve was then generated in order to plot sediment storage capacity for varying spillway heights. This curve showed that a structure built to retain 299 mcy of sediment would require a spillway 155 feet high.

Downstream Actions

The second element in the plan addresses the immediate problem of sediment now moving through the rivers. Some 20 mcy is estimated in the system, migrating downstream in waves. As the river scours at one site, that material deposits at other points along the river.

To trap sediment now in the system and anticipated to move through it during construction of the retention structure, downstream dredging would occur at two sites on the Toutle (LT-1 and LT-3). Material dredged from the river at these sites would be placed in disposal areas outside the 100-year flood plain. Of the sites considered, the Toutle locations offered a number of advantages. First, they have been identified as natural deposition areas; second, they were used successfully to excavate sediments during emergency actions following the 1980 eruptions; and third, with access roads already established, work could begin quickly. Finally, these locations have the greatest amount of potential disposal areas available nearby. This not only reduces the cost of dredging, but also minimizes impacts on the environment.

The downstream dredging contributes to the flexibility of the plan. The level of dredging activity can increase at a given location or cease altogether at another if the region experiences a short rainy season. However, dredging does have limited efficiency. Even with continual dredging at both sites, not all the material currently in the system can be trapped and removed. A large storm or two closely-spaced storms could transport more sediment than the basins hold. In addition the dredging equipment has a limited capacity.

The basins would be operated to remove the majority of material flowing into the Cowlitz. Thus, if operations were begun in FY 85, 14 mcy of the sediment yield predicted in the sediment budget would need removal from the basins in order to prevent sediment from moving into the lower Cowlitz River. During FY 1987-1988, some sediment would be trapped by construction activities during the initial stage of the structure. Once the structure is in place, only minimal downstream dredging would be required because the Cowlitz and Columbia Rivers have the capacity to transport all of the material expected to erode below the structure.

The projected sediment budget will vary from year to year, depending on the severity and timing of storms. Operations at the sediment stabilization basins will be evaluated yearly. Some material could continue to pass into the Cowlitz, but the reduction in sand yield will increase the transport capacity of the Cowlitz River. Sediment accumulated in the riverbed would erode and move into the Columbia River where normal maintenance dredging operations would handle the material as needed.

Under the preferred plan, dredging requirements on the Columbia River would be reduced compared to the no-action condition. Dredging would be confined to the mouth of the Cowlitz River, and for several years the Corps will use available disposal sites along the Columbia River. Early costs will reflect the expensive inland disposal sites, while long-range costs will reflect ocean disposal.

Other Miscellaneous Actions

In addition to the single retention structure and downstream dredging, implementation of the plan may also require other minor actions to insure the continued effectiveness of the plan. Specific work locations have not been identified; however, work activities are expected to include localized reinforcement and repair of existing levees and placement of limited amounts of revetment to prevent excessive bank erosion or damage to existing structures.

Fish and Wildlife Measures

The project contains features to minimize impacts on fish and wildlife resources. The primary measure is a fish bypass facility at the single retention structure. While additional planning and engineering is necessary to determine the complete feasibility of such a facility, preliminary study indicates that passage can be provided. Conceptually, these facilities would consist of a trap and haul operation for adult migrants (adult migrants would be trapped at the foot of the structure and hauled in vehicles upstream of the dam for release), with juvenile passage occurring as part of water releases through the regulating outlet and spillway. The Federal government would pay the cost of construction and evaluation of these facilities, while operation and maintenance would be a State responsibility. The construction costs for these facilities are not separately broken out in table V-2 (Cost Summary). However, the trapping expense is included in the line item "Miscellaneous Works," while the hauling expense is contained in the total for "O&M Monitoring." Preliminary estimates indicate about $1,000,000 for construction and $75,000 for annual operation and maintenance.

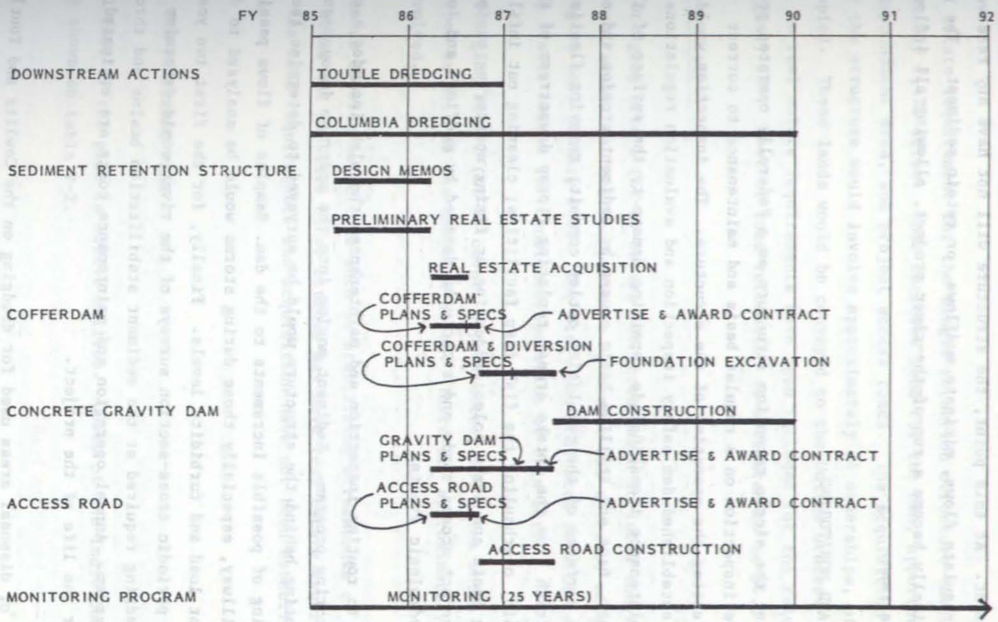
To minimize wildlife impacts associated with the preferred plan, the Corps would manage the reservoir and disposal lands to provide wildlife habitat.

CONSTRUCTION

Preliminary Construction Requirements

Preparations for construction of the retention structure would require some rerouting of roads, clearing of land in the proposed impoundment area, and diverting the North Fork Toutle River. Currently, the State of Washington is studying the public need for State Highway 504, which parallels the North Fork Toutle River at the Green River site. Therefore, requirements for relocation of this highway have not been included in the project estimate (see chapter X for further discussion). Land behind the retention dam would be cleared of floatable debris to prevent debris from clogging the proposed outlet works. Finally, North Fork Toutle River would be diverted by means of a cofferdam and construction of the outlet works. Figure V-2 below presents the proposed construction schedule.

Figure V-2. Proposed Construction Schedule



Final Project Condition

In its final condition, the storage behind the structure will be completely full of sediment. At this point, the structure will not have any reserve capacity to regulate flows, mitigate mudflows, or retain sediment. The project will basically become a run-of-the-river project, allowing all inflow to pass on downstream.

MAINTENANCE AND MONITORING

Once in place, the single retention structure as a Federally operated project would require inspection on a regular basis and maintenance to correct problems affecting the operation of the structure. The inspection would comply with established dam safety inspection and evaluation regulations. Potential maintenance items include repairing damage to the surface of the spillway crest, face and stilling basin caused by sediment erosion and scour; refacing the surfaces of the regulating outlet conduit; removing floating debris and trash from the intake areas; replacing riprap downstream of the stilling basin; overhauling the fish trap facilities; cleaning out infill in the stilling basin and drain holes; adjusting or fixing monitoring equipment; repairing project access roads and structures damaged by mudflows and low frequency hydrologic events.

In addition to routine inspection and maintenance, the plan includes a continued monitoring program. Sediment moving into the upstream impoundment area and accumulating behind the structure would be surveyed to determine the size and scheduling of possible increments to the dam. Samples of flows passing over the spillway, especially those during storms would be analyzed to determine sediment load and turbidity levels. Finally, for the first two years of the project periodic cross-section surveys of the river would determine the level of dredging required at the sediment stabilization basins and throughout the river system. Annual operation and maintenance costs are estimated to be $500,000 for the life of the project.

Maintenance of disposal areas used for dredging on the Cowlitz and Toutle Rivers would consist of placement of limited amounts of revetment to prevent excessive bank erosion of the disposal sites as well as maintenance or reseeding of the required grass cover for those areas.

REAL ESTATE REQUIREMENTS

Single Retention Structure

The real estate requirement for the single retention structure basin covers approximately 7,470 acres. This includes land for the dam, appurtenant structures, impoundment area, and project access roads. The acquisition requirement for the structure would involve approximately 24 ownerships, of which 9 are occupied. These lands would be conveyed to the United States. As stated earlier, no real estate requirements have been included for the relocation of State Highway 504. Cost of road relocation is estimated to be $4.3 million.

Downstream Actions

a. Dredging Site 1 (LT-1) covers 385 acres which includes the riverbed and disposal areas. A local cooperative agreement was executed with the State of Washington on 3 January 1983. The State has indicated it will secure the remaining tracts needed for continued operation at this site.

b. Dredging Site-2 (LT-3) covers approximately 560 acres which includes the riverbed as well as the disposal areas. There are approximately 37 ownerships involved.

Miscellaneous downstream actions such as stabilizing streambanks of dredged disposal areas and possible other actions may have real estate requirements; however, the land requirements and acquisition have not been established at this time.

COSTS OF THE PREFERRED PLAN

The total cost of the plan is $292.2 million. Costs of the individual features are shown on table V-2.

Table V-2

Cost Summary

($000) 1984 dollars

SRD at Green River	
Mobilization/Diversion	$ 3,800
Reservoir Clearing	4,700
Concrete Dam	47,200
Outlet Works	11,400
Miscellaneous Works	3,000
Spillway	29,000
SUBTOTAL	$ 99,100
Contingencies	19,900
E&D and S&A	16,700
O&M/Monitoring	45,000
Real Estate	14,300
TOTAL	$195,000
Downstream Actions	
Cowlitz/Toutle Dredging	
Real Estate	$ 2,000
Sediment Removal	45,000
SUBTOTAL	$ 47,000
Contingencies	9,000
E&D and S&A	8,100
TOTAL	$ 64,100
Columbia River Dredging[1]	
Sediment Removal	$ 33,100
GRAND TOTAL	$292,200

[1] Although the sediment removal cost for Columbia River ($33.1 million) is part of total project costs, it would be funded under the existing authorization for maintaining the 40-foot navigation channel, Rivers and Harbors Act of 23 October, 1962.

BENEFITS OF THE PREFERRED PLAN

Benefits attributable to the preferred plan are the same as those discussed in the NED plan in chapter IV.

Economic and Social Effects

In communities along the lower 20 miles of the Cowlitz River, persistent uncertainty about risks of flooding and volcanic activity have had major social and economic effects. First, elaborate strategies have been developed for responding to potential disasters. Second, some residents in the area show symptoms of severe stress. Their concern is exacerbated by the knowledge that solutions are neither simple nor likely to be implemented without some delay. Some residents have chosen to leave the area. Third, because long-range planning is impossible, investment strategies have changed, delaying decisions on business relocation and expansion.

With a long-term permanent solution approved and implemented, reduced flood hazards would restore normal economic conditions and improve the climate for business and investment. Anxiety and uncertainty among residents would be reduced. Furthermore, the preferred plan would temporarily stimulate the local economy by providing jobs during construction. Partially offsetting the economic stimulus would be a reduction in potential future timber harvesting because of the requirements for the SRS impoundment area. Also, some land would be required for sediment basin disposal sites. However, no major alterations in land use or regional shifts in tax structure would result from the project; these findings (see appendix E) are in conformance with the Cowlitz County Development Plan. In sum, the preferred plan would strengthen the underlying economic base of Cowlitz County and enhance its quality of life.

Prevention of Erosion

In the aftermath of the 1980 eruptions, material dredged from the Cowlitz and Toutle Rivers during emergency actions was placed along the riverbanks. In response to the heavy increase in sediment load, the river channel has shifted radically at a number of points, eroding some disposal sites and adding to the sediment in the river. Once dredging and construction of the single retention structure is underway and the sediment load downstream is decreased, the river channel will stabilize and bank erosion will drop to pre-eruption levels.

Until then, miscellaneous preventive measures--riprap and revetment--would be instituted at threatened sites to stabilize erosion.

Maintenance of Water Quality

Under the preferred plan, water quality could degrade in the short term, but improve in the long term. Current levels of turbidity will persist, and possibly increase, during the two years of dredging at the sediment stabilization basins. However, when the retention structure is in place, the substantial reduction of sediment in the system will lower turbidity and particulate levels.

Protection of Fish and Wildlife

The effects of the preferred plan on fish and wildlife are briefly summarized here; these are further detailed in the Environmental Impact Statement (EIS) included with this report, as well as in the Fish and Wildlife Coordination Act Report, an exhibit to this report.

The placement of a single retention structure on the North Fork Toutle River above the confluence of the Green River would result in the following beneficial and adverse impacts. As sediment is trapped behind the dam, downstream riverbeds and channels would be stabilized and turbidity would be decreased. This would result in maintaining at least a migratory path to the upper Cowlitz River hatcheries, South Fork Toutle, and Green River systems. In addition, this channel stabilization will allow the quicker reestablishment of riparian vegetation. Fish passage facilities will mitigate the blockage to upstream migrants. The reduction of sediment below the structure would provide some spawning and rearing habitat in the main stem Toutle River. However, this benefit could be reduced by potential water quality problems resulting from impoundment. This problem would result from solar heating, raising downstream river temperatures during the summer and fall. The impact of solar heating could be minimized by controlling volumes of water impounded seasonally behind the dam. The sediment buildup behind the structure would adversely impact fish and wildlife, already harmed by the effects of the Mount

St. Helens eruption. To mitigate the loss of wildlife habitat above the structure, reservoir lands will be managed to preserve available habitat for as long as practicable and to include some revegetation at a minimum cost. This loss of wildlife habitat above the structure would be partially offset by the expedited recovery of riparian vegetation below the structure.

Downstream of the retention structure, sediment removal operations, except at the sediment stabilization basins, would also help stabilize river channels and allow vegetation to reestablish. Also, increased turbidity from the dredging operations at the SSB would adversely affect migrating fish.

The preferred plan offers opportunities to minimize the previously addressed negative impacts. Before implementation of the plan, studies would continue to address all justified means and measures of improvement. Further information may be found in exhibit 1, fish and wildlife measures.

Maintenance of Cultural Resources

An evaluation of cultural resources previously identified in the study area is included in the EIS portion of this report. A reconnaissance study has been completed to determine if significant sites exist in the project area. No such sites have been identified in the project area.

ECONOMIC SUMMARY

The preferred plan includes construction of a single retention structure at the Green River site and downstream actions until the structure has become fully effective. The total cost of the plan is $292.2 million.

The recommended plan was formulated using October 1984 prices, an 8-1/8 percent project interest rate, and a 50-year project life. The average annual cost of this plan is $17.9 million on an equivalent annual basis. The resulting benefit-to-cost ratio is 1.55 to 1, with net economic benefits of $9.9 million on an equivalent annual basis.

CHAPTER VI - STAGED CONSTRUCTION

GENERAL

Chapter V identified the NED plan as the preferred plan. This chapter will examine staged construction of the preferred plan, as well as a smaller and larger structure, assuming different sediment budgets. Staging is considered a refinement of the preferred plan and will be further developed and refined during the continued planning and engineering phase, incorporating the latest sediment predictions and cost estimates available. The analysis investigates benefits, costs, and risks associated with staged construction of that structure under various estimated sediment budgets. The discussion closes no options concerning future staging but presents possible strategies for and potential risks of implementing a staging program.

DESCRIPTION OF STAGED CONSTRUCTION

In this analysis, staged construction refers to raising the initial height of the structure following a period in which the storage basin is allowed to fill with sediment. The raises would require modifications to the foundation and raising of the spillway as well.

Considerations for Staging

This approach allows construction of the first increment smaller and less costly than a full size structure. The second stage is constructed only after the previous stage is full and analysis dictates a need for the next increment. Thus, limited resources are used only as needed. While costs may be reduced in early years by building a smaller initial stage, total costs would be greater should the structure be raised to its full height because of construction inefficiencies.

Uncertainties are associated with the sediment projections used in this report. The sediment budget is based on the average observed annual delivery rates since 1981. Should projected estimates prove high, a smaller structure would be adequate. However, as discussed later, certain risks exist when excessive precipitation occurs with attendant flood runoff or mudflows resulting from pyroclastic events.

Another factor affecting staging relates to the physical configuration of the valley and the relationship of structure height to storage capacity. This relationship indicates that for the first 10 percent of storage, (assuming a 177-foot structure), 55 percent of the total cost must be expended. The relationship of incremental costs to incremental raises and incremental storage increases shows that for a small addition of cost, a large increment of storage can be purchased only above a height of 112 feet. Thus, staging for a structure less than 112 feet results in a much higher cost for the volume of storage gained than incremental raises above that height.

METHODOLOGY

As with the sensitivity analysis conducted for the NED plan, sediment budgets have been estimated for 1/2 (1/2 E) and 1-1/2 (1-1/2 E) times the sediment budget (E) used in the report. While the 1/2 E and 1-1/2 E estimated budgets are not a scientific certainty, they do reflect a reasonable range of possible delivery scenarios.

A reactive approach to staging provides the basis for cost development. It assumes a staging strategy of monitoring the impact of annual sediment delivery to project storage. When monitoring indicates efficiency of the structure is decreasing, the next stage is implemented. This strategy reduces initial costs; however, downstream dredging costs would increase to offset reduced storage efficiency until the next stage is completed.

The average annual costs of various sized, staged structures, added to the average annual residual damages, are compared to the cost of maintaining the

base condition. Also presented are risks attributable to infrequent events, such as a 100-year flood event or a mudflow.

COSTS OF STAGED CONSTRUCTION

General

The following section will present assumptions made to develop costs of staged construction using various sediment budgets. Those costs are presented in matrix form and details are described in paragraphs keyed to the matrix.

Assumptions

The costs shown in table VI-1 are based on several assumptions. They relate to when staging would occur and how it would be done.

a. The design budget (E) is representative of the problem although actual delivery rates vary. Lesser and greater sediment budgets (1/2 E and 1-1/2 E) are representative of what could occur, given current knowledge of sediment deliveries.

b. Costs reflect the following implementation schedule:

o - WY/FY 85: CP&E, plans and specifications

o - WY/FY 86: Begin construction (cofferdam)

o - WY/FY 87: First stage of structure effective

o - WY/FY 88: First stage of structure fully effective

c. For a given sediment budget (1/2 E, E, 1-1/2 E), the initial stage selected represents the smallest and least costly structure satisfying storage capacity needs. Staging would be performed when necessary to increase storage capacity as dictated by monitoring of sediment delivery. The selected initial structure sizes are as follows:

Design Budget	Structure Size: Dam Height (ft)	Structure Size: Spillway Elev. (ft above NGVD)
1/2 E	77	865
E	177	965
1-1/2 E	202	990

d. The base condition (Nov.-Dec. 83) level of protection is maintained by the structure and accompanying downstream dredging.

e. Columbia River navigation channel is maintained.

f. Safe levee heights (permanent levees) are used.

g. Projects designed for 1/2 E initially would use a 77-foot-high first stage. This height was selected for comparative purposes only, as a dredging program would be less costly if the sediment budget is 1/2 E (see NED Sensitivity).

h. The storage basin is full and sediment begins flowing over the structure before the decision is made to add the next stage. This results in a 1-year lapse, with sediment continuing to pass the structure and dredging required downstream. A full structure is defined as the condition where the sediment has reached the spillway elevation. Downstream dredging costs are included in all costs.

i. Under staging, the initial foundation, outlet works and spillway are designed only for minimum structure height but have basic provisions allowing changes for future raises.

j. The succeeding stage would bring the structure to the next larger size. Under 1/2 E, this would result in a 4-stage construction program for a 177-foot structure and a 5-stage program for a 202-foot structure.

Results

Table VI-1 displays the total average annual costs for various structures in millions of dollars. In the lower right-hand corner of each box is an index number which refers to the descriptions below.

Table VI-1

Average Annual Construction Costs of Various Sized Staged Structures

($ Millions)

	DESIGN FOR:		
ACTUAL	1/2 E - 77 ft	E - 177 ft	1-1/2 E - 202 ft
1/2 E	10.3 (1)	13.3 (4)	15.4 (7)
E	23.1 (2)	17.9 (5)	20.0 (8)
1-1/2 E	38.3 (3)	23.4 (6)	24.4 (9)

For the purposes of the risks discussion included in the descriptions below, storage capacity required to fully accommodate the 100-year flood sediment inflow or a mudflow are 21 mcy and 75 mcy, respectively. In Table VI-2, the staging sequence for various sized structures is given. The first number is the dam height while the second designates the year that the stage would be constructed and effective. The number in the lower right-hand corner of each box refers to the discussion below.

Table VI-2
Staging Sequence for Staging Sensitivity Analysis

	DESIGN FOR:		
ACTUAL	1/2 E - 77 ft	E - 177 ft	1-1/2 E - 202 ft
1/2 E	77/1987 (1)	177/1987 (4)	202/1987 (7)
E	77/1987 112/1990 142/1993 177/1996 (2)	177/1987 (5)	202/1987 (8)
1-1/2 E	77/1987 112/1990 142/1993 177/1996 202/2002 (3)	177/1987 202/1999 (6)	202/1987 (9)

(1) Design for 1/2 E: Actually Receive 1/2 E. This is a single-stage structure 77 feet high with a total storage capacity of 40 mcy. It represents the lowest overall cost for a first stage. If only the 1/2 sediment delivery occurs, the structure never needs raising. Throughout the life of the structure, risks exist for excess sediment delivery from a 100-year event or the design mudflow. Once completed the structure has no additional capacity to accommodate either the mudflow or the 100-year event.

(2) Design for 1/2 E: Actually Receive E. Initially the structure is built to a 77-foot height. This structure is effective in 1987, as are all structures. This stage performs well until 1989, when pool storage is exhausted and material begins passing downstream, requiring dredging. The

structure is raised 35 feet to a 112-foot elevation in 1990. The structure performs sufficiently through 1991 and begins passing material in 1992 and dredging resumes. In 1993 the structure is raised to 142 feet high. One more raise is required in 1996 to attain a 177-foot structure, with material passing it in 1995. This height would accommodate the E budget and no further stages are required. The capacity of the initial stage is 40 mcy and at its final stage, 299 mcy. The average annual cost shown is the total for all stages. Risks for the first stage are the same as the 77-foot structure described under 1/2 E. These risks are anticipated to remain the same through the fourth stage. Once the fourth stage has been reached sediment levels have decreased and risks begin to improve for the rest of the life of the structure.

(3) Design for 1/2 E: Actually Receive 1-1/2 E. The sequence of construction is similar to the above discussion (2) except that dredging quantities increase in the years when insufficient storage exists. As a result, costs increase for those raises. The staging sequence changes, however, when in 2001 material begins passing the structure again and a 25-foot stage is added in 2002 to raise the dam height to 202 feet. Another stage raising the structure to 202 feet is needed in year 25. Dredging is still required downstream after year 25, however, at that point it becomes more economical to dredge than add another stage. Risks remain high throughout the life of the project because of the high sediment delivery rates.

(4) Design for E: Actually Receive 1/2 E. When designing for E, the least costly approach calls for initially constructing a 177-foot structure with a storage capacity of 299 mcy. It would be effective in 1987. If only half the sediment budget were received, no additional stages would be required. The pool would still fill to the spillway crest but less of the storage between the pool and the S/2 slope would be consumed than if the full budget were received. Downstream actions would be less than if E were received, which would result in a reduction of the total cost for this option over the next condition considered (5). Risks would be reduced over the 77-foot structure (1) because of availability of more storage. Enough storage would exist in this structure until 2002 to accommodate a 100-year event sediment and until 1993 for mudflow sediment.

(5) Design for E: Actually Receive E. This structure is still the same size as (4), 177 feet high, since it was designed for E. Only one stage would be required. The pool will be filled by 1996 and passing some material by 1997. Minimal dredging would be required in the out years but higher than (4). Risks would be higher than (4) because of the structure filling sooner. Capacity exists for the sediment requirements of the 100-year event and mudflows up to 1995 and 1991, respectively.

(6) Design for E: Actually Receive 1-1/2 E. Again the initial structure is 177 feet. With this budget sand would begin passing the structure in 1998 and the structure would be raised to a height of 202 feet in year 15. The raised structure would fill by 2008 with significant dredging required in the out years. Since these costs occur primarily in the future they do not dramatically impact the discounted average annual costs. Because of the increased sediment delivery, risks are greater than in (5). Storage is available to fully accommodate sediment delivery for a mudflow and 100-year event up to 1989 and 1991, respectively.

(7) Design for 1-1/2 E: Actually Receive 1/2 E. Since the structure is designed for 1-1/2 E, it would be built 202 feet high. No staging would be required, and maximum capacity is 1,162 mcy. This capacity provides storage for extreme events, accommodating mudflows and 100-year events up to 2004 and 2022, respectively. This structure has the lowest risk factor of any considered because of its large capacity.

(8) Design for 1-1/2 E: Actually Receive E. The structure would be built to 202 feet as in (7). No staging required but dredging increased over (7), reflected in increased average annual cost. Initially adequate storage would exist to accommodate extreme events but for shorter periods than (7). Storage would exist to fully accommodate sediment requirements for mudflows and 100-year events up to 1994 and 1999, respectively.

(9) Design for 1-1/2 E: Actually Receive 1-1/2 E. Again, the structure would be constructed to a height of 202 feet. No staging is required but dredging will increase over (8), increasing costs. Initially, structure would have same storage as (7); however, it would fill so that material would pass

structure in 2008. Dredging would continue to be required past then. However, those costs do not significantly impact the discounted average annual costs. Capacity exists to fully accommodate sediment requirements for mudflows and 100-year events up to 1991 and 1994, respectively.

Summary

Table VI-3 presents the accomplishments of various sized structures at the Green River site in relation to annual storage, peak storage (100-year), mudflow storage, streamflow regulation (100-year event) and water quality. The key for symbols show that a clear bubble meets considerations, 1/2 bubble partially meets considerations, and a solid bubble does not meet considerations. As an example, a 112-foot structure on the Green River site can accomplish the following: annual storage to eliminate downstream dredging associated with material eroding from the avalanche is initially 11 mcy. The 112-foot structure fully provides for that storage as evidenced by the clear bubble. In year 5 that requirement drops to 8 mcy and the 112-foot structure also meets that consideration. However, by the 10th year, when the annual requirement is 5 mcy, the dark bubble indicates that the structure does not meet that requirement.

In the same fashion, the ability of a 112-foot structure to provide enough storage for the sediment delivery of a 100-year event and mudflow are shown under the next two headings. The streamflow regulation heading, for a 100-year event, refers to the project's ability to regulate peak flows to prevent spillway overflow.

Comparison of Staged Structures with Dredging

Table VI-4 shows the average annual costs (AAC) developed earlier summed with the average annual residual damages (AAD) in millions of dollars and compared with the sum of the average annual costs plus the residual average annual damages of maintaining the base conditions.

TABLE VI-3

ACCOMPLISHMENTS OF SINGLE RETENTION STRUCTURE

SITE	REG. OUTLET	DAM HEIGHT	EVALUATION CONSIDERATIONS																			
			ANNUAL STORAGE				PEAK STORAGE (100-Yr. Event)				MUDFLOW STORAGE				STREAMFLOW REGULATION (100-Yr Event)				WATER QUALITY			
			1987	1990	1995	2005	1987	1990	1995	2005	1987	1990	1995	2005	1987	1990	1995	2005	RES. TEMP.	D/S TEMP.	D/S ENHANCE.	TURBIDITY
STORAGE CAPACITY CRITERIA			11 mcy	8 mcy	5 mcy	2 mcy	14 mcy	14 mcy	14 mcy	14 mcy	75 mcy	75 mcy	75 mcy	75 mcy								
GREEN RIVER (Base Elev. 810)	No	77	○	●	●	●	◒	●	●	●	◒	●	●	●	●	●	●	●	○	○	◒	●
	Yes	112	○	○	●	●	◒	●	●	●	◒	◒	●	●	◒	●	●	●	○	○	◒	●
	Yes	142	○	○	○	◒	◒	◒	●	●	◒	◒	◒	●	○	◒	●	●	○	○	◒	◒
	Yes	177	○	○	○	○	○	○	◒	●	○	◒	◒	●	○	○	◒	●	○	○	◒	◒
	Yes	202	○	○	○	○	○	○	○	◒	○	◒	◒	◒	○	○	○	◒	○	○	○	○
	Yes	272	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

○ Meets Considerations

◒ Partially Meets Considerations

● Does Not Meet Considerations

Table VI-4

Staging - Assuming Reaction to Loss of Efficiency

ACTUAL			DESIGN FOR: SRS @ 77 ft 1/2 E	DESIGN FOR: SRS @ 177 ft E	DESIGN FOR: SRS @ 202 ft 1-1/2 E
1/2 E	SRS	AAC	10.3	13.3	15.4
		AAD	2.4	2.4	2.4
			12.7	15.7	17.8
	D	AAC	8.0	8.0	8.0
		AAD	3.6	3.6	3.6
			11.6	11.6	11.6
E	SRS	AAC	23.1	17.9	20.0
		AAD	2.6	2.6	2.6
			25.7	20.5	22.6
	D	AAC	23.3	23.3	23.3
		AAD	7.1	7.1	7.1
			30.4	30.4	30.4
1-1/2 E	SRS	AAC	38.3	23.4	24.4
		AAD	8.7	7.0	4.7
			47.0	30.4	29.1
	D	AAC	46.9	46.9	46.9
		AAD	9.8	9.8	9.8
			56.7	56.7	56.7

Results from this table indicate that for a 1/2 sediment budget, dredging is always the least costly solution. This was also true for the analysis performed in the NED chapter. The point at which dredging might be preferred to a structure is shown on figures VI-1, VI-2, and VI-3. When compared with similar curves for a single staged structure (as described in chapter IV), there is a slight difference for E and 1/2 E. However, at the estimated sediment budget E, little real difference exists, since staging based on E does not occur until 1/2 E is actually exceeded.

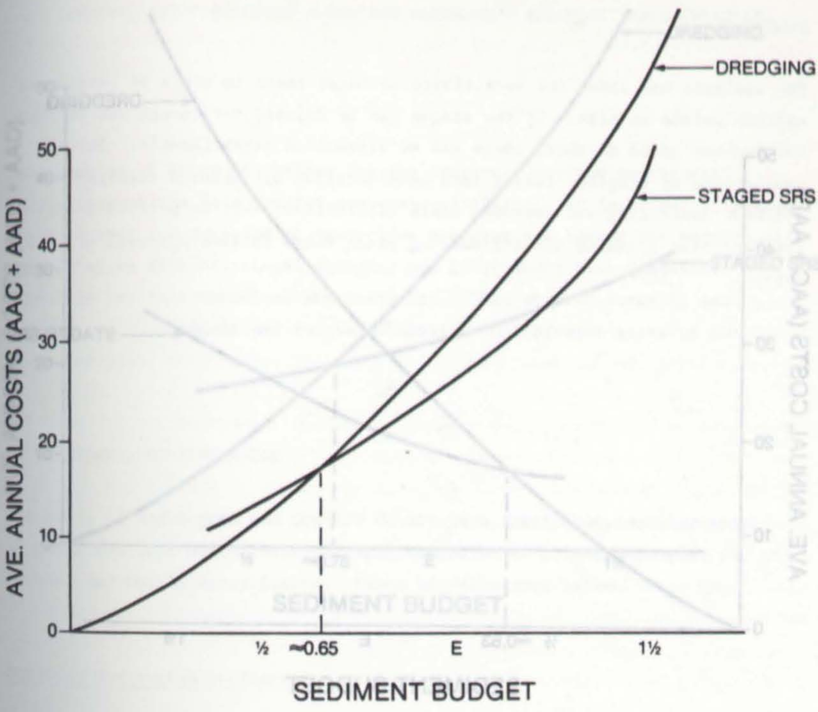


Figure VI-1. Staged Structures Designed for ½E

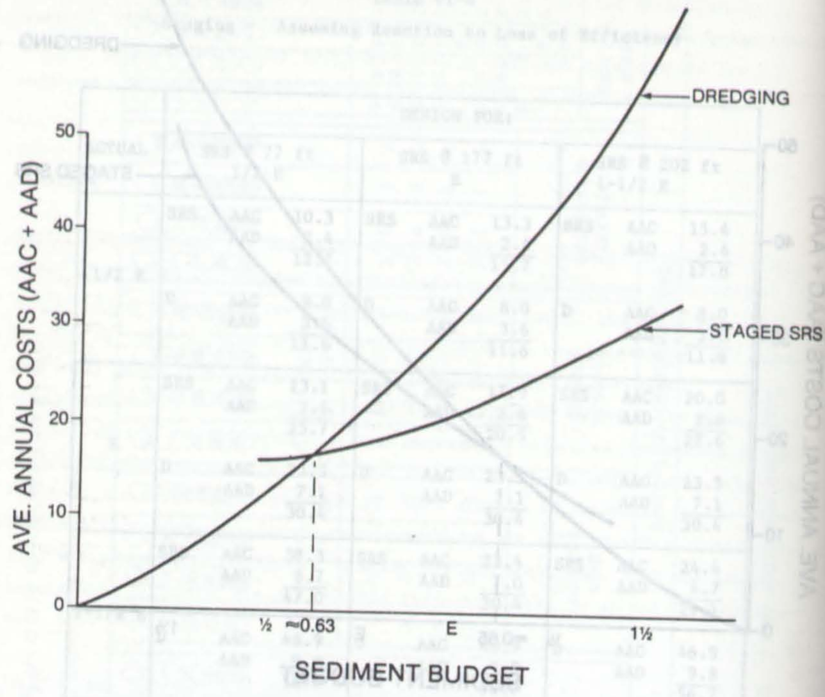


Figure VI-2. Staged Structures Designed for E

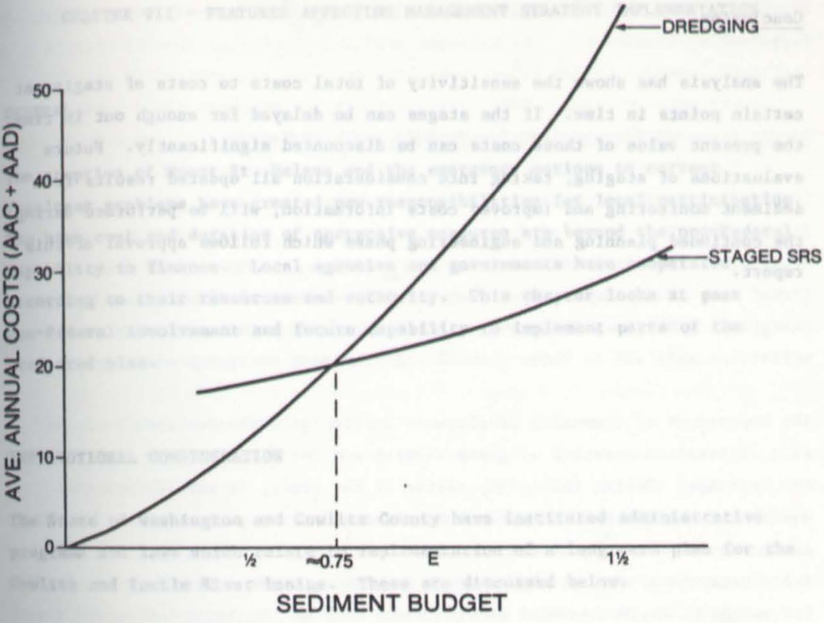


Figure VI-3. Staged Structures Designed for 1½E

Conclusion

The analysis has shown the sensitivity of total costs to costs of staging at certain points in time. If the stages can be delayed far enough out in time, the present value of those costs can be discounted significantly. Future evaluations of staging, taking into consideration all updated results from sediment monitoring and improved costs information, will be performed during the continued planning and engineering phase which follows approval of this report.

GENERAL

The eruption of Mount St. Helens and the emergency actions to correct resultant problems have created new responsibilities for local participation. The high cost and duration of corrective measures are beyond the non-Federal capability to finance. Local agencies and governments have cooperated according to their resources and authority. This chapter looks at past non-Federal involvement and future capability to implement parts of the preferred plan.

INSTITUTIONAL CONSIDERATION

The State of Washington and Cowlitz County have instituted administrative programs and laws which relate to implementation of a long-term plan for the Cowlitz and Toutle River basins. These are discussed below.

Building Moratorium in Flood Hazard Areas

The county initiated a building moratorium following the 18 May 1980 eruption and subsequent mudflow. It prohibits issuance of building permits, mobile home placement, and sewage disposal permits in county-designated flood hazard areas for habitable structures (Cowlitz County, 1983). In the Cowlitz County Watershed Management Plan, the Board of County Commissioners directed their Department of Community Development to continue the building moratorium until a long-term solution is implemented.

Mount St. Helens Flood Warning/Monitoring Network

As described in Section I, this network was developed before the eruption and refined afterwards, primarily because of the threat of failure of Spirit Lake

blockage. This warning system is expected to be kept in operation for the foreseeable future.

Dredge Disposal Site Reclamation/Stabilization Ordinance

In the Cowlitz County Watershed Management Plan, the County Commissioners also directed the Department of Community Development to design an ordinance requiring reclamation of disposal sites in order to insure their future beneficial use. Planning uses for past and future disposal sites is an important management practice. Large quantities of disposal material from future activities will add to those accumulated from past emergency actions.

The Department of Community Development drafted an ordinance that included such reclamation measures as grass seeding and fertilizing, bank protection, and drainage. During the agency review of the draft, it was learned that a portion of the $5 million appropriated by the State legislature in 1983 for dredge spoils site acquisition could be used for site rehabilitation. The State Department of Natural Resources is working on securing long-term funding for managing the State-owned sites. Since many of the largest disposal sites have been or are being acquired by the State, the County concluded that a dredge spoils rehabilitation ordinance was unnecessary at this time.

Local Sponsorship

Current Federal policy requires local interests to participate in project costs. This participation can be as limited as implementing a zoning ordinance or as extensive as furnishing lands, easements and rights-of-way. Other possible local contributions may include responsibility for operation and maintenance of the project and/or sharing in the construction costs. As discussed below, the County and State have already participated as sponsors for emergency measures already undertaken.

The State of Washington, Cowlitz County, and other local interests have already contributed to Federal emergency actions since the eruption. In addition to maintaining the Cowlitz County Flood Warning System, the State has

spent $1 million to procure disposal sites for dredged material and another $3.5 million (Senate Bill 3519) has been expended for related activities. For example, the State acquired lands at the Lower Toutle (LT-1) sediment stabilization basin, where dredging has continued into 1984. After erosion threatened the abutments of the I-5 bridge, the State of Washington Department of Transportation placed revetment and sheet pile at the bridge to prevent further damage and possible closure of this major transportation route.

Within Cowlitz County, local sponsors signed cooperative agreements to provide lands, easements and rights-of-way for emergency levee raising. To date the local Governments have expended approximately $7.4 million on activities resulting from the eruption of Mount St. Helens.

Fish and Wildlife Mitigation

Developing a reasonable and justifiable fish and wildlife mitigation plan for this project is a difficult and complex task. Not only do the fish and wildlife impacts associated with the project need separation from the habitat losses due to the eruption, but fish and wildlife impacts associated with a single retention structure need weighting against the downstream benefits attributable to such a structure. These problems are complicated by the rapidly changing fish and wildlife habitat of the area due to recovery of eruption-caused damages and the ongoing sedimentation problem.

The development of this mitigation plan is based upon the recommendations of the U.S. Fish and Wildlife Service, as found in their Fish and Wildlife Coordination Act Report (CAR); see exhibit 1 of this report. While the recommendations in the CAR exceed those proposed as part of this plan, mitigation does minimize the majority of adverse fish and wildlife impacts directly associated with the plan. Proposed mitigation does not overlap existing federal and state programs or land management plans.

Mitigation proposed in the preferred plan includes the construction of fish bypass facilities as part of the single retention structure. While additional

planning and coordination with the resource agencies will determine the specific facilities eventually constructed, the facilities considered for this report consist of a trap and haul facility for adult migrants with juvenile passage occurring as part of water releases through the regulating outlet and spillway. Construction and evaluation of these facilities will be a Federal cost and operation and maintenance, a state cost-sharing responsibility. Also proposed is the management of reservoir and disposal lands to minimize the loss of wildlife habitat, as described in chapter V.

DIVISION OF RESPONSIBILITIES

Because of the unique nature of the problems arising from the eruption and the novel strategies required for mitigating the impact to flood control and navigation on the Toutle, Cowlitz and Columbia Rivers, the following cost-sharing formula is proposed.

The Recommended Proposal for Cost Sharing

In the recommended proposal for cost sharing, the Federal portion will cover construction cost of the single retention structure including fish bypass facilities; construction costs of all downstream actions; operations and maintenance costs of the retention structure including cost of the sediment monitoring program.

The non-Federal share will be the costs of all lands, easements, rights-of-way for construction and maintenance of the project; maintenance of the disposal sites necessary for downstream actions; all other mitigation costs of the project; operation and maintenance of the by-pass facility; and costs associated with relocation.

Table VII-1
Recommended Proposal for Cost Sharing

	Percentage	
	Federal	Non-Federal[2]
Single Retention Structure	Construction Costs[1]	Lands, easements, ROW, Relocations
Downstream Actions	Construction Costs	Lands, easements, ROW, Relocations
Columbia River Dredging[3]		

1. Includes trapping and hauling and monitoring costs.
2. All other mitigation costs.
3. Responsibilities for Columbia River maintenance dredging are already established under the authorized 40 foot navigation channel Rivers and Harbors Act of 23 Oct, 1962. Federal responsibilities are the cost of dredging. Among the local sponsor responsibilities are providing lands, easements and rights-of-way for disposal areas for construction and subsequent maintenance of the project.

Table VII-2

RECOMMENDED

PROPOSED COST SHARING

	Total Project Cost ($000)	Flood Control: Total Allocation (87% of Total Project	Flood Control: Federal Cost	Flood Control: Non-Federal Cost	Navigation: Total Allocation (13% of Total Project)	Navigation: Federal Cost	Navigation: Non-Federal Cost
SRD at Green River							
Mobilization/Diversion	$ 3,800	$ 3,300	$ 3,300	$	$ 500	$ 500	$
Reservoir Clearing	4,700	4,100	4,100		600	600	
Concrete Dam	47,200	41,100	41,100		6,100	6,100	
Outlet Works	11,400	9,900	9,900		1,500	1,500	
Miscellaneous Works	3,000	2,600	2,600		400	400	
Spillway	29,000	25,200	25,200		3,800	3,800	
SUBTOTAL	$ 99,100	$ 86,200	$ 86,200		$ 12,900	$12,900	
Contingencies	19,900	17,300	17,300		2,600	2,600	
E&D and S&A	16,700	14,500	14,500		2,200	2,200	
O&M/Monitoring	45,000	39,200	39,200		5,800	5,800	
Real Estate	14,300	12,400		12,400	1,900		1,900
TOTAL	$195,000	$169,600	$157,200	$12,400	$ 25,400	$23,500	$1,900
Downstream Actions:							
Cowlitz/Toutle Dredging							
Real Estate	2,000	1,700		1,700	300		$ 300
Sediment Removal	45,000	39,200			5,800	5,800	
SUBTOTAL	$ 47,000	$ 40,900	$ 39,200	$ 1,700	$ 6,100	$ 5,800	
Contingencies	9,000	7,800	7,500	300	1,200	1,200	
E&D and S&A	8,100	7,000	6,700	300	1,100	1,100	
TOTAL	$ 64,100	$ 55,700	$ 53,400	$ 2,300	$ 8,400	$ 8,100	$ 300
Columbia River Dredging*							
Sediment Removal	$ 33,100				$ 33,100	$33,100	
GRAND TOTAL	$292,200	$225,300	$210,600	$14,700	$ 66,900	$64,700	$2,200

* - See footnote 3 from table VII-1.

CHAPTER VIII - SUMMARY OF PUBLIC INVOLVEMENT, VIEWS AND COMMENTS

OVERVIEW

This feasibility report completes the planning process initiated by an earlier study, the Comprehensive Plan for Responding to the Long-term Threat Created by the Eruption of Mount St. Helens, Washington. The Corps forwarded the Comprehensive Plan to the President's office in November 1983. Following a screening process, the plan recommended five strategies for further evaluation:

- o Limited Permanent Evacuation
- o Sediment Stabilization Basins
- o Multiple Retention Structures with Dredging
- o Multiple Retention Structures without Dredging
- o Single Retention Structure

During the months of November and December 1983, numerous meetings were held in the study area to present these strategies to the public and obtain their input. These presentations also included a discussion of alternatives for Spirit Lake, also covered in the Comprehensive Plan report. The input for the Spirit Lake solution, addressed in the Spirit Lake Decision Document and EIS, will not be addressed in this report.

Because the Feasibility Report utilizes much of the information and analysis developed during the preparation of the Comprehensive Plan, only one public meeting was scheduled during the 45-day public review period that was held in Longview, Washington on 29 November 1984. A formal presentation describing the preferred plan preceded public testimony.

This section summarizes the public, state, agencies, and local government reactions to the Comprehensive Plan and Feasibility Report for responding to the eruption of Mount St. Helens. It utilizes the public meeting transcripts, oral and written comments made at the meetings, and letters submitted for the record following the meetings. A synopsis of the comments on one of the principal components of the plan, the sediment strategy, is contained in the following paragraphs.

SYNOPSIS OF COMPREHENSIVE PLAN COMMMENT

The public reaction to strategies designed to solve the sediment problem ranged from a preference for continuation of the current dredging program to

recommendations for construction of a sediment retention structure on the Toutle River. Major public sentiment backed the solution which would resolve the problem by retaining the material in the Toutle River. A large majority expressed support of the single retention structure on the Toutle above its confluence with the Green River. People from the Toutle Valley generally opposed any dams on the Toutle River.

The Governors of Washington, Oregon, and Idaho, and the Community Consensus Position (which was signed by 39 representatives of local government, service and civic organizations) also expressed support for the single retention structure. The U.S. Fish and Wildlife Service agreed to this strategy with provisions for fish passage. The U.S. Geological Survey preferred to control sediment as close to its source as possible to minimize impacts of downstream sediment transport and stated a concern that a large increment of storage (100 mcy) should be provided on any structure as early as possible to accommodate the possibility of a major event.

Public Involvement Program

The public involvement period began on 29 November 1983, with the news release announcing availability of the Comprehensive Plan report and public meeting dates. Comments for the record were received through 5 January 1984. During that 37-day period, the Corps made 12 presentations to an estimated 1,300 people.

The major component of the public involvement program centered on six public meetings during December. These meetings were held at locations and times indicated below.

Date	Location	Time
5 December	Vancouver, Washington	1300
5 December	Toutle, Washington	1930
6 December	Castle Rock, Washington	1930
7 December	Kelso, Washington	1930
8 December	Kelso, Washington	1230
8 December	Woodland, Washington	1930

In addition to the six formal public meetings, the Corps gave six other presentations to local groups requesting background on the study.

Date	Location	Group
22 November	Longview, Washington	Longview Chamber of Commerce
1 December	Toutle, Washington	Residents of Toutle
9 December	Olympia, Washington	Washington State Agencies
13 December	Vancouver, Washington	Mount St. Helens Scientific Advisory Board
14 December	Longview, Washington	Longview Rotary
14 December	Olympia, Washington	Washington Legislative Select Committee
20 December	Woodland, Washington	Woodland Chamber of Commerce

The first public meeting held in Vancouver, Washington, provided an opportunity for residents of the Portland-Vancouver metropolitan area to give their views. The afternoon meeting also attracted staff from various agencies. Navigation interests were represented since Portland and Vancouver are the two major ports in the region.

A large percentage of the local population attended the Toutle public meeting. Although not threatened by flooding from the sediment problem, people in the Toutle Valley would be affected by a sediment retention dam on the Toutle River. In addition, the population felt threatened by any failure of the natural dam impounding Spirit Lake.

Castle Rock, located on the Cowlitz River near its confluence with the Toutle River, would be endangered not only by flooding from a breach of the Spirit Lake dam but also from loss of flood control caused by deposition of sediment in the Cowlitz River. This third public meeting was the first where both issues were of equal concern to the attendees.

The next public meeting took place in the Longview-Kelso area, the most populated and developed area threatened by flooding. This evening session had the highest attendance of the six meetings. The major concerns were both flood control and navigation, affecting both individuals and businesses.

The fifth meeting was also held in the Longview-Kelso area during the afternoon. This session was timed to encourage attendance by night shift workers and elderly people. Some staff from local agencies and businesses also attended.

The final public meeting occurred in Woodland, a city on the Lewis River. The only direct impact on this city would develop if the Corps implemented the B_1 alternative for the Spirit Lake component, since this alternative included the discharge of water into the Lewis River. Discussion at this meeting focused on alternatives for a permanent Spirit Lake outlet.

Meetings were planned at locations and times to insure maximum attendance. Advance notice of the meetings appeared in local newspapers and in announcements over television and radio. The format of each meeting included a formal presentation of the study, public testimony, and a question and answer period. It is estimated that a total of 1,000 people attended the meetings. In addition, 257 written comments were received initially, with another 69 comment sheets received through the mail.

Public Comment by State, Agencies and Other Public Groups

Congressman Don Bonker, State of Washington

Sediment Strategy. Accepts Comprehensive Plan recommendation that the single retention structure is the best and the most cost-effective solution.

State of Washington

Sediment Strategy. Prefer single retention structure located on the Toutle River above its confluence with the Green River, based on the following concerns:

(a) Sediment should be contained in the upper reaches of the Toutle River above its confluence with the Green River,

(b) Permanent solution should minimize impacts on residents, transportation routes, and on fish and wildlife.

Other Concerns. The Administration's proposal for local and State cost-sharing, as described in the Comprehensive Plan is totally unacceptable. Traditional cost-sharing formula should apply and include costs for fish and wildlife mitigation measures. Favor a greater margin of safety and subsequent permanent Spirit Lake level 10 to 20 feet below the recommended 3,440 feet.

State of Oregon

Sediment Strategy. Supports the single retention structure based on the following concerns:

(a) Least costly alternative,

(b) Less risk than with multiple retention structures,

(c) Immediate action so congressional authorization can occur in 1984,

(d) Impairment of navigation access to ports of lower Columbia of serious economic concern.

Federal Emergency Management Agency, Washington, D.C.

Sediment Strategy. Urge rapid progress towards the final solution.

Other Concerns. Support 100-year flood level as minimum flood protection level to be achieved and maintained.

U.S. Fish and Wildlife Service

Sediment Strategy. Concerned about fish passage and loss of wildlife habitat. Recommend single retention structure because impacts to fish and wildlife are less damaging than with the multiple retention structures.

Department of Interior, Geological Survey

Sediment Strategy. Sediment management strategy should provide a large increment of storage (100 mcy or more) as soon as possible and impound the sediment as close as possible to its source. This strategy would minimize negative impacts of downstream sediment transport and accommodate sediment yields generated by major volcanic, seismic, and hydrologic events.

Other Concerns. Mount St. Helens is in an episode of eruption that could last for several decades. This is a period of geologic and hydrologic instability which must be planned for. There are concerns about the impact of Spirit Lake discharge on the chemical and biological quality of alternative receiving waters.

Community Consensus Position

Sediment Strategy. Single retention structure on North Fork Toutle at the Green River site is the preferred alternative for sediment control.

Other Concerns. If further studies indicate safety problems exist for west side tunnels, would not oppose tunnel to Smith Creek as long as mitigative measures are implemented to protect Lewis River drainage.

Urges use of the traditional formula wherein the Federal Government pays 100 percent of construction costs.

The following local government, service, and civic organizations signed the Community Consensus Position document:

- o Cities, County, and Regional Government
  - Cowlitz County Board of Commissioners
  - City of Longview
  - City of Kelso
  - City of Castle Rock
  - City of Kalama
  - Cowlitz-Wahkiakum Governmental Conference

- o Service Districts
  - Public Utility District No. 1 of Cowlitz County
  - Longview School District Board of Directors
  - Kelso School District Board of Directors
  - Castle Rock School Board of Directors
  - Kalama School District
  - Beacon Hill Sewer District Board of Commissioners
  - Consolidated Diking Improvement District No. 1 (Longview)
  - Consolidated Diking Improvement District No. 3 (Kelso)

- o Ports
  - Port of Longview Board of Commissioners
  - Port of Kalama
  - Port of Portland
  - Port of Astoria Commission
  - Pacific Northwest Waterways Association

- o Political Organizations
  - Cowlitz County Republican Central Committee
  - Cowlitz County Republican Men's Club
  - Cowlitz County Republican Women's Club
  - Cowlitz County Democratic Central Committee

- o Civic Organizations
  - Cowlitz Economic Development Council
  - Longview Chamber of Commerce
  - Kelso Chamber of Commerce
  - Castle Rock Chamber of Commerce
  - Kalama Chamber of Commerce
  - Yale/Cougar Community Council

o Unions

- International Longshoremen's & Warehousemen's Union Local 21
- United Food and Commercial Workers, Local 367
- Association of Western Pulp and Pulp Workers Local 153

o Service Organizations

- Kelso Rotary Club
- Pioneer Lions Club

o Other Organizations

- Mount St. Helens Protective Association
- Willapa Hills Audubon Society
- Castle Rock Lions Club
- National Association of Women in Construction
- Longview Early Edition Rotary

Cowlitz Conservation District, Kelso, Washington

Sediment Strategy. Recommends a single retention structure as far upstream as feasible above the confluence of Green River and North Fork Toutle River.

Other Concerns. Mount St. Helens disaster is a national concern. Federal Government should pay for all expenses.

Port of Portland, Portland, Oregon

Sediment Strategy. Urges the single retention structure as the best approach.

Other Concerns.

(a) Recognize that this is a national issue.

(b) Disagree that more study will improve sediment estimates. Feel current ones are best available.

(c) Nothing suggests that waiting will lessen magnitude of problem.

(d) Single retention structure has advantage over multiple retention structures in flexibility, flood control, and environmental impacts.

Port of Lewiston, Lewiston, Idaho

Sediment Strategy. Recommends single retention structure.

Other Concerns. Mount St. Helens is a national issue and should not be approached through cost-sharing means of local government. Prevent sediment from entering the Columbia River and impacting navigation in the river channel.

Port of Vancouver, Vancouver, Washington

Sediment Strategy. Recommends single retention structure in the interest of time and in the long term, money.

Other Concerns. Maintain a safe and assured 40-foot channel from the Pacific Ocean to the Port of Vancouver. Action is needed now.

Mount St. Helens Chamber of Commerce (Toutle River Valley)

Sediment Strategy. Continue to dredge the Cowlitz and Columbia Rivers.

Idaho Transportation Council

Sediment Strategy. Single retention structure is described as satisfying most criteria and reducing the costs of navigation.

Other Concerns. Impairment of navigational access to the lower Columbia River is a serious economic concern to Idaho. Columbia River navigation channel is essential to the economy of the Pacific Northwest and should be maintained.

Pacific Rim Trade Association

Sediment Strategy. Solution should be implemented now to contain material in the Toutle Basin, leaving the available Columbia River dredged disposal sites for other dredging needs.

Other Concerns. Depend very heavily on the Columbia River and its tributaries to transport products. Action should be taken immediately.

Weyerhaeuser Company, Longview, Washington

Sediment Strategy. Better information is needed about the amount, timing and source of sedimentation in the rivers before determining the best way to handle the sediment problem.

Other Concerns. Mitigation for fish and wildlife is secondary to life and property concerns and is not needed. Funding of the solution(s) should be entirely from the Federal level.

Mount St. Helens Scientific Advisory Board

Sediment Strategy. No position stated.

Other Concerns.

(a) Safety of people downstream should be first priority.

(b) Flexibility must be part of any selected alternative.

(c) Presented these recommendations to U.S. Forest Service.

Summaries of Written and Oral Responses

The consensus of public testimony supported the single retention structure as a solution to the sediment problem. The two exceptions were the Mount St. Helens Chamber of Commerce, who preferred continued dredging, and the Weyerhaeuser Company, who recommended waiting for better information before making a selection. The U.S. Geological Survey stated no preference among the strategies, urging only that sediment be controlled as close to its source as possible.

Other concerns expressed by the public included the following points. Those commenting on cost-sharing supported 100 percent Federal funding. Many comments requested quick action for a solution to both the Spirit Lake and sediment problems. The U.S. Geological Survey conveyed several technical concerns about various alternatives to both the Spirit Lake and the sediment problems. The Federal Emergency Management Agency advocated the 100-year flood level as the minimum maintained for the communities along the Cowlitz River. The U.S. Forest Service, the Federal management agency for the lands around Spirit Lake, did not provide a position on the various alternatives.

This summary of responses as shown in Figure VIII-1, reflects a range of community sentiments, extending from a community interested only in impacts of a specific Spirit Lake outlet (Woodland) to a community concerned only in effects of single retention structures (Toutle). It encompasses a cross section of populations from large communities to small and of publics including environmental groups, agencies, counties, and ports.

A common area of agreement among all providing their views was the need for a quick solution to the problems created by the eruption of Mount St. Helens and a desire for relief from cost sharing.

In addition, several informal groups of individuals provided written and oral recommendations to various levels of the United States Army Corps of Engineers and to the Army Secretariate. An example of this input was that of Alden Jones, who opposed any dam construction based upon the premise that the Toutle River was armoring itself sufficiently from natural means so that the flood threat from sediment would correct itself in time.

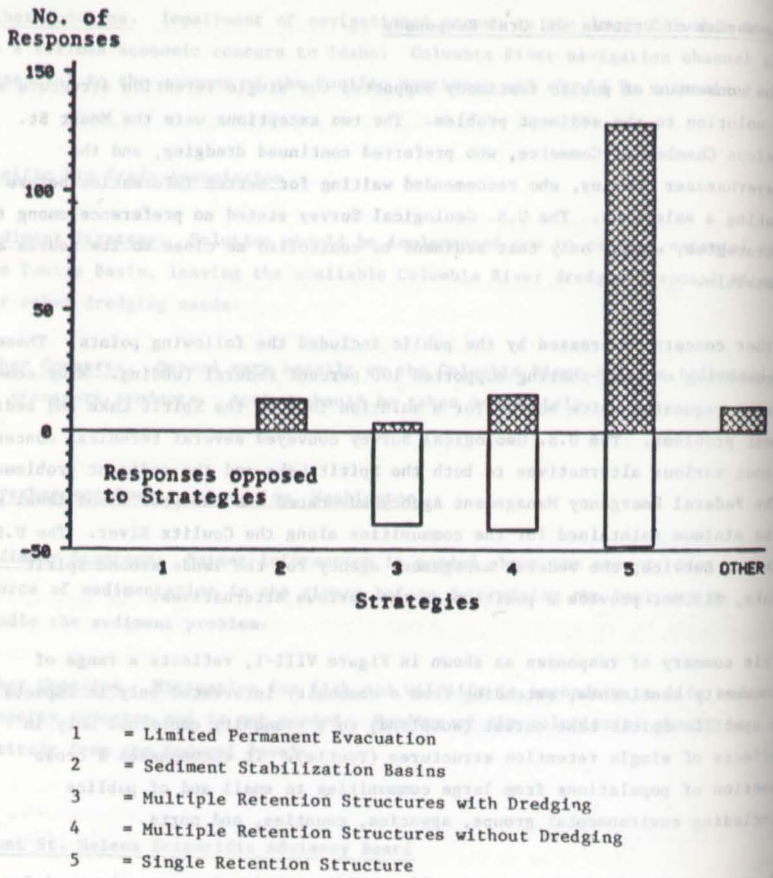


Figure VIII-1. Summary of Response to Comprehensive Plan

SYNOPSIS OF FEASIBILITY REPORT COMMENT

Public Involvement Program

The Public meeting on the Feasibility Report attracted 103 people, 27 of whom testified. Of the indivicuals who spoke at the meeting 15 supported and 12 opposed the preferred plan as shown in table VIII-1. Most of the opponents were members of the Toutle Valley Preservation Association and residents of Toutle Valley.

No new issues surfaced at that public meeting that were not discussed during the 1983 meetings. All speakers urged that a quick decision should be made on which alternative will be implemented. Most speakers also opposed the proposal for local cost sharing of lands, easements and rights-of-way.

Table VIII-1 TESTIMONY AT
29 NOVEMBER 1984 PUBLIC MEETING

Opposition	12 Total
Toutle Valley Preservation Association	
Mount St. Helens Chamber of Commerce	
Individuals (10)	
Support	15 Total
Washington Department of Emergency Management	
Cowlitz County Board of Commissioners	
Cowlitz Economic Council	
Longview Chamber of Commerce	
Longview Fibre Company	
Longview Treatment Plant (Water Dept.)	
Pacific Northwest Waterways Association	
Port of Longview	
Port of Kalama	
Port of Portland	
Cowlitz County League of Women Voters	
Individuals (4)	

Public Comment by State, Agencies and Other Public Groups

In addition to oral testimony presented at the public meeting, written comments were received from Federal, State and local agencies, groups and private individuals during the 45-day public review. A graphic summary of written responses by group and position is shown in figure VIII-2. These letters and appropriate responses are contained in exhibit 2 of this report.

As with the oral testimony written opposition to the preferred plan came primarily from individuals in the immediate study area, some of whome are members of the Toutle Valley Preservation Association. No Federal, State or local agency opposed the preferred plan although some changes were suggested. Local agencies and individuals opposed cost-sharing from local sources. Some State and Federal agencies requested more fish and wildlife mitigation as a federal portion of the project costs. Responses from agencies are summarized below.

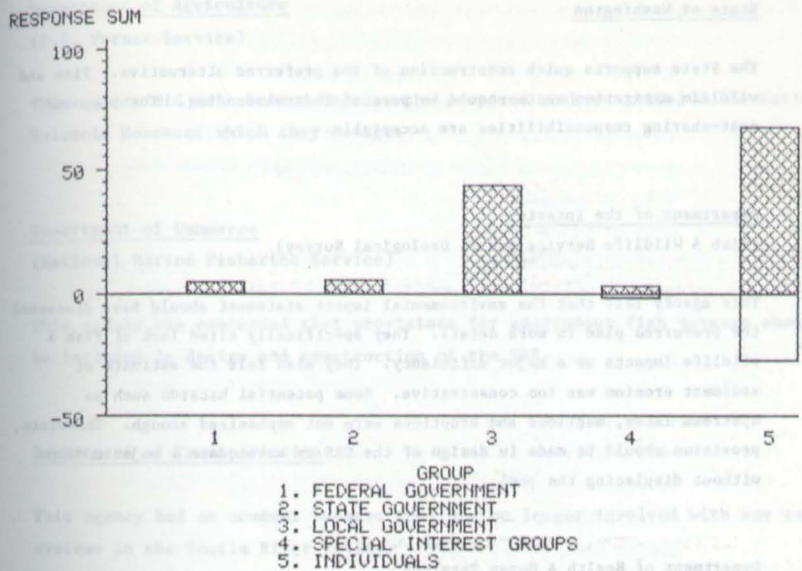


Figure VIII-2 Summary of Response to Feasibility Report

State of Washington

The State supports quick construction of the preferred alternative. Fish and wildlife mitigation costs should be part of Federal funding. The proposed cost-sharing responsibilities are acceptable.

Department of the Interior

(Fish & Wildlife Service & U.S. Geological Survey)

This agency felt that the environmental impact statement should have discussed the preferred plan in more detail. They specifically cited lack of fish & wildlife impacts as a major dificiency. They also felt the estimate of sediment erosion was too conservative. Some potential hazards such as upstream lakes, mudflows and eruptions were not emphasized enough. Therefore, provision should be made in design of the SRS to accomodate a major mudflow without displacing the pool.

Department of Health & Human Services

This agency supported implementation of Alternative 1 from the Comprehensive Plan - (limited permanent evacuation). They did not comment on any alternatives currently being considered.

Environmental Protection Agency

This agency felt that the environmental impact statement should have been more detailed in discussing the preferred alternative. Fish & wildlife impacts were not discussed in enough detail.

Department of Agriculture

(U.S. Forest Service)

This agency did not comment because the proposed work was outside the National Volcanic Monument which they manage.

Department of Commerce

(National Marine Fisheries Service)

This agency was concerned that provisions for anadromous fish passage should be included in design and construction of the SRS.

Department of Transportation

This agency had no comment because they are no longer involved with any road systems in the Toutle River Valley.

Community Consensus Position (43 Entities)

The preferred alternative is the best choice for solving potential flooding and navigation problems. The concept of cost sharing is understood and supported in concept by the local governments, but they do not feel this cost should be borne by the cities or county. A solution to the sediment problem needs to be implemented as soon as possible.

- o Cities, County, and Regional Government
  - Cowlitz-Wahkiakum Governmental Conference
  - Cowlitz County Board of Commissioners
  - Clark County Board of Commissioners
  - Columbia County Board of Commissioners
  - Skamania County Board of Commissioners
  - City of Longview
  - City of Kelso
  - City of Castle Rock
  - City of Kalama
  - City of Woodland
  - Town of Cathlamet

- o Service Districts
  - Public Utility District No. 1 of Cowlitz County
  - Longview School District Board of Directors
  - Kelso School District Board of Directors
  - Castle Rock School Board of Directors
  - Kalama School District
  - Beacon Hill Sewer District Board of Commissioners
  - Consolidated Diking Improvement District No. 2 (Woodland)
  - Consolidated Diking Improvement District No. 3 (Kelso)
  - Cowlitz Economic Development Council

- o Ports
  - Port of Longview Board of Commissioners
  - Port of Kalama
  - Port of Portland
  - Port of Vancouver, U.S.A.
  - Pacific Northwest Waterways Association
  - Wahkiakum Port District #2

- o Political Organizations
  - Cowlitz County Republican Central Committee
  - Cowlitz County Republican Men's Club
  - Cowlitz County Republican Women's Club
  - Cowlitz County Democratic Central Committee
  - Cowlitz County Democratic Men's Club

- o Civic Organizations
  - Longview Chamber of Commerce
  - Kelso Chamber of Commerce
  - Castle Rock Chamber of Commerce
  - Kalama Chamber of Commerce
  - Yale/Cougar Community Council

- o Unions
  - International Longshoremen's & Warehousemen's Union Local 21
  - United Food and Commercial Workers, Local 367
  - Association of Western Pulp and Pulp Workers Local
  - Teamster's Local #58
  - Carpenter's Union Local #1707

- o Other Organizations
  - Willapa Hills Audubon Society

Toutle Valley Preservation Association & Mt. St. Helens Chamber of Commerce

These groups feel that erosion of the debris avalanche is stabilizing faster than anticipated in the Feasibility Report. Therefore, other minimal, non-structural actions such as bank protection and vegetation planting would be effective in stopping downstream problems.

Weyerhaeuser Company

This company emphasized the need to refine the sediment budget before final selection of the preferred plan. The Green River Site for an SRS is supported if current analysis is substantiated by continuing sediment monitoring. No additional resource mitigation is justified beyond that indicated in the Feasibility Report. Project funding should be a federal responsibility.

FINAL

CHAPTER IX - ENVIRONMENTAL IMPACT STATEMENT
AND SECTION 404(b) EVALUATION

Cowlitz Toutle Feasibility Study

The responsible lead agency is the U.S. Army Engineer District, Portland.

Abstract

The 18 May 1980 eruption of Mount St. Helens left a debris avalanche containing an estimated 3 billion cubic yards of material on the upper reaches of the North Fork Toutle River. Material eroding from the avalanche moves downstream, some of it passing through to the ocean and the remainder depositing in the river channels. The sediment deposits, if not removed, could eventually create a flooding possibility for downstream urban areas. An active dredging program, however, has removed the infill and maintained the 100-year flood protection authorized by PL 98-63. A number of alternative measures to control sediment movement have been considered, including no action and a nonstructural plan to evacuate permanently a large portion of the lower Cowlitz flood plain while raising levees to increase flood protection for Kelso and Longview. Structural measures considered include sediment stabilization basins, multiple retention structures both with and without dredging, and a single sediment retention structure. A sediment retention structure located on the North Fork Toutle upstream of the Green River confluence was selected as the preferred alternative. With this plan the maximum amount of sediment would be retained in the upper watershed. The retention structure could be built in stages, allowing flexibility in responding to actual rates of erosion from the debris avalanche. The environmental effects of the preferred alternative include blocking the passage of anadromous fish into the North Fork Toutle River above the confluence with the Green River. Fish passage is proposed to mitigate this impact. Retention of sediment behind the structure would substantially reduce sediment deposition in the Toutle and Cowlitz Rivers, allowing the re-establishment of riparian vegetation and the natural restoration of fish and wildlife populations and habitat downstream of the structure. Requirements for dredging in the lower Cowlitz and Toutle Rivers to maintain flood protection would be reduced. Sedimentation in the Columbia River would be reduced, requiring less dredging to maintain the navigation channel and less disposal of dredged material on riparian lands. Economic benefits would result from the reduction in potential flood damages. Adverse social and psychological conditions now evident and that would increase with a no-action situation, would be lessened as residents received assurance that their homes and communities were once again safe from destruction by flooding.

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Note: Information, displays, and maps referred to in the main report and appendixes are incorporated by reference into this EIS.

SUMMARY OF MAJOR CONCLUSIONS AND FINDINGS

Preferred Alternative

The Corps of Engineers considered five alternative plans to control the movement of sediment from the debris avalanche on Mount St. Helens. The alternatives include: limited permanent evacuation, sediment stabilization basins, multiple retention structures with dredging, multiple retention structures without dredging, and a single retention structure (SRS). No action was also considered.

Engineering and economic studies determined that a single retention structure on the Toutle River would be the most efficient and cost-effective means of controlling sediment from the debris avalanche. The studies analyzed three sites as potential locations for a single retention structure: LT-3, on the main stem Toutle River at river mile (RM) 9.5; Kid Valley, on the North Fork Toutle River at RM 6.9; and Green River, on the North Fork Toutle River at RM 13.5. Based on these analyses and their potential environmental effects, the Green River site with a 177-foot structure and associated actions was selected as the preferred alternative.

Physical Effects

An SRS at the Green River site would impound 299 mcy of sediment covering 3,267 surface acres during the 50-year project life. Ultimately 411 mcy of sediment would be trapped over 4,100 surface acres. Total project lands at the SRS site would total 7,470 acres. Staged construction could provide flexibility in responding to actual sediment accumulation. Ponding of water would occur behind the structure, which would detain river flows and increase sediment trapping efficiencies. Two years of downstream dredging in the Cowlitz and five years in the Columbia would be necessary to remove material eroded downstream of the site and material passed downstream during construction.

Biological Effects

The Green River SRS would block passage of anadromous fish to upstream areas. However, of the sites considered, the Green River site would block the least amount of area and would allow unimpeded fish passage to the South Fork Toutle River and the Green River. If fish passage is provided around this structure, this fish blockage would be alleviated. Over the period of sediment delivery, sediment would be trapped behind this structure and would cover the North Fork Toutle River and portions of tributary streams.

The Green River sediment retention structure would allow the stream channel downstream to stabilize, and riparian wetland and upland areas to develop. Establishment of vegetation behind this structure would be retarded by sediment accumulation. Once sediment stabilization is achieved, vegetation would reappear, developing into wetlands or wet meadows.

Social and Economic Effects

Positive effects to local social and economic conditions would result from the control of sediment movement by a retention structure at the Green River site. Community viability in the lower Cowlitz floodplain would improve with this alternative because the threat of flood damages would be reduced. Business and industry could invest and expand without the uncertainties which had existed due to the continuing flood threat.

Cultural Resources

Investigation of the site of the Green River SRS and the sediment impoundment area indicates that no significant cultural resources are present in the project area.

I. PURPOSE AND NEED

This draft Environmental Impact Statement accompanies a draft Feasibility Report. The purpose of the feasibility study is to develop plans for a permanent solution to the sediment problem and to recommend congressional authorization and funding for construction.

Public Concerns: Intense public concern exists for protection of life and property in the areas of the Lower Cowlitz and Toutle River valleys subject to the threat of flooding resulting from continued sedimentation. Material eroding from the debris avalanche on Mount St. Helens is being deposited on the lower river channels, increasing the risk of flooding in the developed areas. Containing the greatest population concentration in Cowlitz County, the lower Cowlitz River flood plain is the area of greatest potential damage. Also, the long-term preservation of the economic and social viability of the communities on the lower Cowlitz is a major concern.

The fish and wildlife resources of the Toutle River system are the natural resources of greatest concern in the study area. Mudflows following the 18 May 1980 eruption severely harmed fish and wildlife populations, but the passage of time is expected to correct the damage done by nature. All of the alternative sediment control plans have been evaluated to determine their effects on the long-term recovery process of fish and wildlife habitat and populations.

Planning Objectives: The primary planning objectives of this study are: (1) the reduction of flood threat to life, property, and transportation systems and (2) the maintenance of navigation on the Columbia River. Other planning objectives encompass protection of water quality, reduction of bank erosion (including areas used for dredged material disposal), protection of fish and wildlife resource, maintenance of cultural resources, and minimization of adverse effects on the local economy.

II. ALTERNATIVES

INTRODUCTION

This Feasibility Report constitutes the second major stage in evaluating alternative measures and plans for controlling sediment from the Mount St. Helens debris avalanche. The first stage involved the Comprehensive Plan, which identified and screened through a plan formulation process measures to control the sediment or reduce damages. These measures and the screening process are described in appendix A, "Comprehensive Plan, the Planning Process." The analysis of alternative actions in the Comprehensive Plan determined the single retention structure alternative the most efficient and cost-effective means of meeting the planning objectives. The Feasibility Report follows up on the Comprehensive Plan by focusing on three alternative locations and a range of alternative sizings for the single retention structure.

This Environmental Impact Statement covers both the alternative plans described in the Comprehensive Plan and the alternative site locations for the single retention structure analyzed in this Feasibility Report. This is consistent with the regulations of the Council on Environmental Quality for implementing the procedural provision of the National Environmental Policy Act (40 CFR 1502-14).

PLAN FORMULATION: ALTERNATIVE MEASURES CONSIDERED

Most of the actions considered in this study were derived from measures taken during the emergency response to the eruption of Mount St. Helens. The Corps of Engineers has been able to draw upon field experience in an unprecedented, complex situation. This experience served as a pre-selection process. Of the 13 measures selected for screening, all have either been field tested or derived from actions applied in the study area. In addition, the Corps' wide experience in comparable flood-threat situations served in the determinations of the preliminary screening.

Measures considered for inclusion in plans addressing flood protection and reduction of navigation impacts included the following:

- o Temporary Evacuation: Evacuation of residents from vulnerable areas at times of high threat of flooding.
- o Limited Permanent Evacuation: Permanent evacuation of areas upstream of Longview and Kelso, Washington. Federal, State, or local government would purchase property. Use of the area would be limited thereafter.
- o Land Use Regulations: Zoning restrictions and moratoriums on construction in threatened areas.
- o Seeding and Planting: Seeding and planting of appropriate vegetation in the devastated areas around Mount St. Helens, with fertilization of nutrient-poor sediment.
- o Floodproofing: Alteration of structures to reduce or eliminate damage from flooding; to be fully effective, measure requires maintaining access to structure.
- o Raise Bridges: Raising of Interstate Highway 5 bridges and the Burlington-Northern Railway which span the Toutle River.
- o Raise Cowlitz Levees: Raising of levees along the Cowlitz River in areas of greatest potential flood damage, from Castle Rock to the mouth of the Cowlitz River.
- o Cowlitz Erosion Control: Stabilization of erosion from dredged material disposal areas developed during emergency actions after the major eruption, or from interim work, would be accomplished by resloping and riprapping.
- o Cowlitz Dredging: Dredging all or part of the Cowlitz River between its mouth and confluence of the Toutle River.
- o Channel Constrictions: Placing groups of pilings in a row across the river current; constriction at times of high flow tends to create "ponds" behind the pilings, thus reducing water velocity and promoting deposition of sediment.
- o Sediment Stabilization Basins (SSB): Continued excavation of ponds at areas where the Toutle River naturally flattens; the ponds reduce flow velocity, causing sediment to fall out.
- o Multiple Retention Structures (MRS): Consists of construction of rockfill dams. These structures reduce water velocity; as a result, sediment settles out. High flows pass over a spillway.
- o Single Retention Structure (SRS): Construction of a large retention structure to capture eroding sediment. Floods would pass over a spillway. Construction could be phased, as needed, until all eroded material is stored.

These measures were screened in two steps. In the first screening, the following criteria were applied:

Basic: 1. Provides flood protection
2. Reduces impacts to navigation

Other: 1. Stabilized river banks
2. Maintains water quality
3. Minimized impacts to fish and wildlife

Measures that passed initial screening were subjected to more pointed, specific criteria of a second screening, based on the following questions:

- To what extent does a measure trap sediment in the upper Toutle River Basin? The more sediment that moves into the Cowlitz River, the more problems it creates.
- Does the measure intend to use available, nearby sites for dredged or excavated materials? The farther materials are moved, the higher the cost.
- To what extent does the measure allow for fish migration? The smaller the river blockage, the greater potential for accommodating fish passage.
- Is the measure consistent with current and planned land use? Prime agricultural or other desirable land should not be used for dredged material disposal areas.
- Is the measure compatible with other agency actions and authorities? Does the measure compete with other agency actions and can a potential sponsor participate in implementation?
- How effective is the measure? Is the measure implementable and can the measure be implemented in time to satisfy the planning objectives?
- Is the measure acceptable to the public and the State of Washington as well as local governments?

ALTERNATIVE PLANS

The second screening identified five measures warranting consideration as alternative plans. These alternative plans are discussed briefly below.

Limited Permanent Evacuation

Lands and improvements in the Cowlitz River flood plain upstream of Longview-Kelso would be purchased and allowed to flood as the Cowlitz River filled with sediment. Lexington and part of Castle Rock would be included in the purchase. Some 5,000 people would receive relocation assistance. The flood plain would include the Cowlitz Valley from Longview to Toledo. Additional rights-of-way would be required for levees in Longview and Kelso. Then levees would be raised and set back to accommodate higher river levels. The I-5 and Burlington-Northern bridge and their approaches, would be raised where they cross the Toutle and Coweman Rivers. Extensive dredging would be required on the Columbia River and possibly on the Cowlitz River as well.

Sediment Stabilization Basins

Sediment stabilization basins (SSB) would be located at three sites on the Toutle River where SSB's have been operated before. SSB's are excavated sumps in the river which slow stream currents so that the sediment settles out. This process requires year-round dredging and extensive off-site disposal. Low trapping efficiency during peak flows would require dredging in the Cowlitz and Columbia Rivers.

Multiple Retention Structures with Dredging

Earth and rockfill structures would be constructed across the Toutle River at four sites. These 40-foot-high structures would prevent sediment from passing in all but extreme flood conditions. All four structures would be built concurrently under this management strategy. Material would be dredged from behind these structures on an as-needed basis in order to maintain trapping capacity. Off-site disposal would be required for the large volume of dredged material. Additional dredging would be required in the Cowlitz and Columbia Rivers.

Multiple Retention Structures without Dredging

Structures would be incrementally constructed across the Toutle River at three sites. These 160- to 190-foot-high structures would prevent sediment from passing in all but extreme flood conditions. Structures would be built in sequence with the downstream structure being built first. As sediment was trapped behind the structures, it would not be removed, but spillways would be raised as needed. Downstream measures would be required to deal with the material already in the system below the structure, including dredging on the Cowlitz and Columbia Rivers.

Single Retention Structure

A single retention structure would be constructed to prevent sediment from passing in all but extreme flood conditions. Sediment trapped behind the structure would not be removed. Downstream measures would be required for two years to deal with the material already in the system below the structure, including dredging on the Cowlitz and Columbia Rivers.

Three sites have been identified for location of an SRS: LT-3 located on the main stem Toutle River at approximately River Mile (RM) 9.5 at the mouth of Hollywood Gorge near Tower; Kid Valley located on the North Fork of Toutle River at approximately RM 6.9 near Kid Valley; and Green River, also located on the North Fork of the Toutle River at approximately RM 13.5, just upstream from the mouth of the Green River. Each of these sites has physiographic features ideal for construction of a sediment trap. They are composed of both narrow segments of the river valley, where a structure can be built within rock abutments, and a much wider valley segment upstream, with a broad flood plain area capable of storing large volumes of both sediment and water. The configuration of the single retention structure would differ depending on the location and on whether or not staged construction is used. Generally, the structure would consist of an RCC gravity dam, an ungated overflow spillway discharging into a stilling basin, and an outlet structure to provide flow and water quality control.

NO ACTION

In this alternative, the Federal Government would take no structural or nonstructural action to control the deposition of sediment in the lower Toutle and Cowlitz Rivers; however, the 40-foot navigation channel in the Columbia River, an existing Federal project, would be maintained. Sediment transport and deposition in the Toutle and Cowlitz Rivers would continue unchecked, as described in the section "Environmental Effects of Alternatives" of this environmental impact statement.

BASE CONDITION

A base condition has been selected which recognizes the continuing Federal responsibility for flood protection measures much as those implemented periodically since the May 1980 eruption. Continuation of interim flood protection on the lower Cowlitz is authorized by Public Law 98-63, enacted in 1983.

The base condition represents the level of flood protection which existed following the completion of Cowlitz River dredging in December 1983. Using data developed for the sedimentation analysis described in appendix C, quantities of material dredged to maintain the base condition have been estimated. These quantities, listed in appendix D, exhibit 1, amount to 113 mcy over the study period. Dredging would occur at the mouth of the Toutle, in the vicinity of Castle Rock, and on the lower Toutle River. The location of both dredging and disposal would be determined as the need arises. A list of potential disposal sites for future use is contained in appendix D, exhibit 1. Information available at this time is insufficient to clearly define the timing and extent of needed dredging and disposal activities; therefore, a more detailed assessment of the environmental impacts of these actions would be required prior to implementation. Continued dredging of 71 mcy would also be required in the Columbia River to maintain the navigation channel.

NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN (PREFERRED PLAN)

The National Economic Development (NED) plan calls for constructing a single retention structure on the North Fork Toutle River at approximately river mile 13.5, about two miles upstream of the Green River confluence. The structure would be 177 feet above the existing streambed with a spillway height of 155 feet.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

PHYSICAL ENVIRONMENT

	Toutle River	Cowlitz River	Columbia River
No Action	651 mcy of material eroding from the debris avalanche will enter the North Fork and main stem Toutle River between 1985 and 2035. Gravel will settle out in the upper North Fork; heavy sedimentation in lower reaches and channel braiding.	Total sediment deposition would be about 78 mcy by 2035.	Deposition in the Columbia would require dredging an additional 145 mcy to maintain the federally-authorized navigation channel.
Base Condition	39 mcy of sediment would be removed from lower Toutle.	Sediment would be removed from lower Cowlitz as needed. Up to 74 mcy would be removed to maintain base level flood protection. Many new disposal sites would be required, at varying distances from river.	Up to 71 mcy would be removed from Columbia navigation channel.
Limited Permanent Evacuation	Same as no action.	Same as no action.	Same as no action.
Sediment Stabilization Basins (SSBs)	Would require extensive disposal areas.	Sedimentation in Cowlitz would be reduced compared to no action.	Sedimentation in Columbia would be reduced compared to no action.
Multiple Retention Structures (MRS) with dredging	Permanent structures would retain sediment in Toutle.	Sediment in Cowlitz would be reduced compared to no action.	Sediment in Columbia would be reduced compared to no action.
MRS without dredging	Sediment would be trapped in the Toutle and permanently retained while passing river flows.	Sedimentation in Cowlitz substantially reduced compared to no action.	Sedimentation in Columbia substantially reduced compared to no action.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

PHYSICAL ENVIRONMENT

	Toutle River	Cowlitz River	Columbia River
Single Retention Structure (SRS)	Material eroded from debris avalanche would be retained in Toutle. Material would continue to be carried from sources downstream of the structure for two years. Increase in water temperature could occur (up to 7° to 9°F) due to ponding behind SRS. Downstream effect would diminish rapidly.	Sedimentation in Cowlitz substantially reduced compared to no action.	Sedimentation in Columbia substantially reduced compared to no action.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

BIOLOGICAL ENVIRONMENT: FISHERIES

	Toutle River	Cowlitz River	Columbia River
No Action	Continued perturbation of N. Fork and main stem Toutle River for at least 35 years; recovery of fishery habitat estimated to require at least 75 years.	Continued sedimentation and channel braiding could significantly reduce value of this river as a migratory channel for anadromous fish. Sediment would continue to cover spawning areas. High turbidity levels would continue.	Sedimentation in the lower Columbia and estuary would have adverse impacts to fisheries resources. Major dredging activities would cause much turbidity.
Base Condition	High turbidity levels during dredging operations; upper Toutle and tributaries would remain accessible to anadromous fish.	High turbidity and hazards to fish passage during dredging operations.	Increased turbidity during dredging operation; losses of riparian vegetation from disposal.
Limited Permanent Evacuation	Same as no action.	Over the long term, new habitat would be created as the river meandered and formed new channels, backwaters, and oxbows.	Sedimentation would be reduced compared to no action.
Sediment Stabilization Basins	Same as base condition.	Over the long term, new habitat would be created as the river meandered and formed new channels, backwaters, and oxbows.	Sedimentation would be reduced compared to no action. Positive fisheries effects.
MRS with Dredging	Fish passage blocked to most of Toutle River and tributaries. Fish ladders could be installed, but removal of sediment would create additional hazards above structures.	Improved conditions in Cowlitz for fish migration. High turbidity levels during dredging behind MRS.	Reduced sedimentation in the river and estuary compared to no action. Positive fisheries effects.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

BIOLOGICAL ENVIRONMENT: FISHERIES

	Toutle River	Cowlitz River	Columbia River
MRS without Dredging	Fish passage blocked to upper Toutle River basin and tributaries.	Improved conditions for fish migration. Both sedimentation and turbidity reduced compared to no action.	Positive benefits to Columbia River fisheries as sediment is retained in Toutle River system.
Single Retention Structure (SRS)	Fish passage blocked above structure; mitigation is possible. Some loss of habitat with sedimentation above the structure. Recovery of downstream channel and habitat would be accelerated, providing fishery benefits.	Improved conditions for fish migration. Both sedimentation and turbidity reduced compared to no action.	Positive benefits to Columbia River fisheries as sediment is retained in Toutle River system.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

BIOLOGICAL ENVIRONMENT: WILDLIFE

	Toutle River	Cowlitz River	Columbia River
No Action	Natural recovery of wildlife habitat over long-term.	Slow recovery of riparian habitat.	Major adverse effects to wildlife habitat due to increased dredging and disposal needed to maintain navigation channel.
Base Condition	Riparian and upland areas would be covered with dredged material, eventually revegetating.	Riparian and upland areas would be covered with dredged material, eventually revegetating.	Much less disposal than no action.
Limited Permanent Evacuation	Same as no action.	Similar to no action; increase in wildlife habitat in long term.	Similar to no action.
Sediment Stabilization Basins	Riparian lands would be covered with dredged material eventually revegetating as upland habitat.	Riparian habitat would recover more rapidly than if no action were taken.	Less dredging and disposal would be needed to maintain navigation channel, with less impacts on riparian habitat.
MRS with Dredging	Extensive riparian areas on Toutle would be adversely effected by infill and disposal.	Riparian habitat would recover more rapidly than if no action were taken.	Substantial reduction in need for dredging of navigation channel; reduced effects on riparian lands compared to no action.
MRS without Dredging	Pool areas would be filled, but could eventually become valuable habitat. Recovery of riparian vegetation downstream would be accelerated.	Riparian habitat would recover more rapidly than if no action were taken.	Substantial reduction in need for dredging of navigation channel; reduced effects on riparian lands compared to no action.
Single Retention Structure (SRS)	Establishment of upstream vegetation would be delayed until erosion of debris avalanche stabilizes.	Riparian habitat would recover more rapidly than if no action were taken.	Substantial reduction in need for dredging of navigation channel; reduced effects on riparian lands compared to no action.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

HUMAN ENVIRONMENT:	SOCIAL EFFECTS
No Action	Major adverse social effects as sediment infill in Cowlitz River causes increased flooding.
Base Condition	Beneficial effects as flood protection for lower Cowlitz is maintained.
Limited Permanent Evacuation	Some positive effects as threatened property is purchased and residents are relieved of risk of personal and financial losses. Negative effects would result from breaking up of existing communities and social systems as residents seek new locations for homes and businesses.
Sediment Stabilization Basins	Some positive effects as action is taken to deal with sediment.
MRS with Dredging	Beneficial effects as community concerns are relieved by positive action to control sediment.
MRS without Dredging	Beneficial effects as community concerns are relieved by positive action to control sediment.
Single Retention Structure (SRS)	Beneficial effects to community viability as sediment is retained in upper Toutle Valley.

COMPARATIVE EFFECTS OF ALTERNATIVE PLANS

HUMAN ENVIRONMENT:	ECONOMIC EFFECTS
No Action	Loss of economic base and employment opportunities to Cowlitz River flooding. Loss of tax base to local governments.
Base Condition	Beneficial economic effects as physical risks to business are reduced. Increased disposal site needs would reduce income opportunities from affected agricultural lands.
Limited Permanent Evacuation	Same as no action except for Longview-Kelso. Long-term benefits to areas receiving flood protection as physical risks to businesses are reduced.
Sediment Stabilization Basin	Beneficial economic effects as physical risks to businesses are reduced. Some jobs would be created by long-term operation of SSBs. Loss of income from lands used for sediment disposal.
MRS with Dredging	Beneficial economic effects as physical risks are reduced. Some jobs would be created by construction of retention structures and dredging.
MRS without Dredging	Beneficial economic effects as physical risks are reduced. Some jobs created by construction of MRS.
Single Retention Structure (SRS)	Beneficial effects to downstream communities as flood protection is restored. Will require removal of existing residences.

COMPARATIVE EFFECTS OF ALTERNATIVE SRS SITES*

	LT-3	Kid Valley	Green River
Physical Environment	SRS with a height of 107 ft. would retain 21 mcy; would cover approximately 1,030 acres. Downstream action: removal of 98 mcy from Toutle and Cowlitz, 68 mcy from Columbia.	SRS with height of 318 ft. would retain 463 mcy; would cover approximately 7,800 acres. Downstream action: removal of 27 mcy from Toutle and Cowlitz, 15 mcy from Columbia.	SRS with height of 177 ft. would retain 299 mcy; would cover approximately 3,267 acres. Downstream actions: removal of 29 mcy from Toutle and Cowlitz, 15 mcy from Columbia.
Fisheries	Anadromous fish passage to all water upstream blocked, including South and North Fork Toutle and Green River.	Anadromous fish passage blocked to Green and upper North Fork Toutle River.	Anadromous fish passage to upper North Fork Toutle River would be blocked above SRS.
Wildlife	Habitat in pool would be inundated by sediment; vegetation would reestablish over the long term. Downstream dredging would affect large areas of habitat.	Habitat in pool would be inundated by sediment; vegetation would reestablish over the long term. Downstream dredging would affect large areas of habitat. Would affect elk wintering range.	Habitat in pool would be inundated by sediment; vegetation would reestablish over the long term. Downstream dredging would affect some areas of habitat.
Social and Economic Effects	Removal of 13 residences. Portion of County Road and utilities would be inundated. Extensive downstream dredging would require disposal on agricultural lands.	Removal of 34 residences, State Highway 504, a County Road and utilities. Downstream dredging would require disposal on agricultural lands.	Nine residences would be removed. Downstream dredging would require disposal on agricultural lands.

*Several SRS heights were evaluated for each site. The least costly SRS at each site has been used for this comparison.

III. AFFECTED ENVIRONMENT

PHYSICAL ENVIRONMENT

The North Fork Toutle River has its origins on the northwest slopes of Mount St. Helens. Its upper valley contains massive amounts of material from the debris avalanche released by the May 18, 1980 eruption. Downstream of the debris avalanche, The North Fork courses through the material deposited by mudflows to its confluence with the South Fork, forming the Toutle River. As the gradient of the stream bed decreases in the lower valley, sedimentation increases, causing channel infilling, increased channel widths, and bank erosion. At the confluence of the Toutle and Cowlitz Rivers, substantial deposition and bank erosion occurs.

Upstream of the Toutle River confluence (RM 20), the Cowlitz is relatively clean; below the confluence the Cowlitz carries the sediment load delivered by the Toutle. Substantial deposition of sediment occurs in the Cowlitz; the huge mounds of material excavated from the channel and placed on the shorelines near Castle Rock evidence the sedimentation which has continued since the May 18, 1980 eruption. Sediment is also transported by the Cowlitz to the Columbia. These rivers are in a state of transition, seeking an equilibrium following the addition of billions of cubic yards of erodible material into the system by the eruptions of Mount St. Helens.

Other streams, less affected by the eruptions, contribute flows to the system. The major tributaries to the Toutle River are the Green River and the South Fork Toutle River. The May 18 blast affected both of these streams. A mudflow caused erosion and deposition throughout the South Fork Toutle River Valley. The Green River watershed was primarily affected by ashfall produced by the blast. These streams are now relatively clean and contribute only small amounts of suspended sediment to the system. The blast denuded the upper watersheds of these streams and of the North Fork Toutle River valley, affecting their hydrologic characteristics.

The debris avalanche is 17 miles long and over 600 feet deep in some locations. It averages 150 feet deep, tapers down to 10 feet of depth at the toe, and has an overall slope of about 3 percent. The total estimated volume of the avalanche is about 3 billion cubic yards. The material in the avalanche varies in size from silts and clays ("fines"), to sand, gravel, cobbles, and boulders.

The fine material, clays and silts, are easily eroded and transported. These particles move downstream suspended in the flow and are carried into the Columbia River. Few fines are expected to remain in the Toutle-Cowlitz River system. Medium and fine sand-size material is the major source of sedimentation. Sand is transported through the steeper gradient reaches of the North Fork and Toutle Rivers, but as the river gradient becomes less steep and the flow less rapid, the sand particles deposit, particularly in the lower 20 miles of the Cowlitz River.

BIOLOGICAL ENVIRONMENT: FISHERIES

Prior to the eruption, streams in the Cowlitz-Toutle watershed supported anadromous and resident fish populations. Anadromous fish included wild run and hatchery-produced fall and spring chinook, coho salmon, winter and summer steelhead trout, and sea-run cutthroat trout. Hatcheries accounted for the majority of the anadromous fish production in the basin containing the Cowlitz and Toutle River drainages.

The eruption of Mount St. Helens significantly affected the fishery of this area, although the degree of impact varied by tributary. The existing condition is, however, not static but reflects the dynamic condition of a disturbed environment. The fishery, dependent upon the quality and quantity of available habitat, continues to be affected by ongoing sedimentation, while slowly recovering toward the pre-eruptive condition. The Toutle River fishery resource has recovered before, after prior eruptions of Mount St. Helens; and it is expected to recover through time to a condition similar to that of the pre-eruption state. Any description of the current condition of this resource

must, consequently, be viewed as a temporary condition with improvement underway. Estimates of recovery are found in greater detail in the without-project alternative condition. By river system, the following conditions exist.

Toutle River. The present condition of fish habitat in the Toutle River system varies greatly, depending upon the degree of impact caused by the eruption and the extent of continued perturbation. For example, the eruption did not affect Alder Creek (a tributary to the North Fork Toutle above the Green River), and it currently provides productive habitat. At present, these smaller tributaries, such as Alder Creek, provide the major spawning and rearing habitat available in the upper North Fork Toutle. Eventual major production, however, is more closely related to the habitat provided by the larger streams: the North Fork Toutle, South Fork Toutle, and Green River. As described in greater detail in the sediment appendix, the continuing sedimentation and erosional processes affect these major tributaries to varying degrees. It is projected that the North Fork Toutle will continue, as is currently the case, to experience major sediment deposition from the debris avalanche. This impact and associated channel destabilization will prevent the reestablishment of productive fisheries habitat for some time. (Estimates of recovery are found in the No Action Condition, of this chapter). The Green River and South Fork Toutle are not experiencing the habitat-limiting impacts of the North Fork Toutle and are showing "signs" of recovery. However, the lack of riparian vegetation which provides shading to maintain cool waters necessary for production limits fish production. Currently, high stream temperatures, particularly on the Green River, affect production adversely.

The main stem Toutle River continues to experience the effects of habitat-inhibiting sedimentation. This continuing erosion creates a stream where fish must contend with turbidities higher than any stream in America, if not the world; a stream that continuously shifts course and does not allow the re-establishment of mature riparian vegetation; a stream where sediment continues to bury stream gravels. In whole, it is a stream where the continued existence of an anadromous fish run is a tribute to the survival instinct of species. Throughout the Toutle River Basin, eruption-related events affected about 135 miles (77 percent) of the streams used by anadromous fish. This included all of the larger streams, about 101 miles, and 34 miles (46 percent)

of the accessible tributaries. About 62 miles of resident fish habitat were also harmed.

Besides the problems affecting natural anadromous fish production in the basin, hatchery production which adds substantially to overall production from this basin continues lost. Mudflows rendered the Toutle Salmon Hatchery as well as the Deer Creek rearing pond inoperable. Since hatcheries produced approximately 70 percent of the salmon and 60 percent of the steelhead production in this basin, this loss greatly influences eventual production.

Cowlitz River. The Cowlitz River serves primarily as a migratory pathway for anadromous salmon and trout produced in the Toutle and upper Cowlitz systems, although some rearing and spawning habitat existed prior to the eruption. A large spawning run of smelt continues to use this river.

The Cowlitz River below the confluence of the Toutle River remains severely affected by the sediment as the Toutle. Spawning gravels once present are buried under 10 feet of sediment. The sediment delivery to this river reach persists, creating difficult passage conditions. Above the confluence of the Toutle River, the upper Cowlitz is unchanged from the pre-eruptive condition. Pre-eruption anadromous fish hatchery production of the Cowlitz River reach approximated three times that of the Toutle River basin. With the severe damage that has occurred in the Toutle system, the upper Cowlitz fish now make up the majority of anadromous fish population in the basin.

Hatcheries in the upper Cowlitz River provide the majority of this production. These hatcheries compensate for fish losses associated with the Tacoma City Light dams on the upper Cowlitz. They produce fish at or near maximum capacity to provide a Cowlitz River fishery.

Columbia River. The Columbia River is critically important to the region's anadromous fish populations. It is the major migratory corridor for the region and provides important rearing habitat. While the Columbia continues receiving huge amounts of sediment, the impact of this sand and silt on the fishery resource is unclear. It is believed, however, that the higher turbidity and shoaling from this additional sediment does adversely affect the fisheries resource.

BIOLOGICAL ENVIRONMENT: WILDLIFE

Existing vegetation and other factors directly influence the reestablishment of wildlife populations. The eruption resulted in varying impacts to the vegetation and, hence, wildlife populations. Like the fisheries habitat previously described, the status of wildlife habitat is dynamic; recovery is underway.

Toutle River. The eruption severely affected Toutle River wildlife habitat, although the degree of impact varies considerably by area. Mudflows caused loss of riparian vegetation along the lower reaches of the Toutle, while areas nearer the mountain suffered from blast effects which damaged whole forest communities. Currently, channel meandering continues to impede the establishment of riparian vegetation along much of the drainage. Ongoing sedimentation continues to retard recovery within this flood plain corridor. In areas away from this influence, the recovery of wildlife habitat is occurring quite rapidly.

Of interest is the success of elk populations reinvading the upper Toutle River basin. Feeding on early seral-stage vegetation and grass plantings on the lower debris avalanche, these elk have shown a high reproduction rate. However, during a severe winter the lack of winter range in this area may limit the success of these populations.

Cowlitz River. This area previously suffered debasement from the numerous residential and commercial developments along its banks prior to the eruption. Mudflow associated with the eruption further degraded this area and the need for disposal areas during emergency dredging operations also reduced the limited wildlife habitat available. Consequently, Cowlitz River wildlife populations remain low.

Columbia River. The lower Columbia River provides valuable wildlife habitat. The riparian/wetland communities support abundant avian populations including important migratory and wintering waterfowl.

The confluence of the Cowlitz and the Columbia contains the area of greatest concern currently. The need to maintain a sump to protect the Columbia River navigation channel from sedimentation has required a vast disposal area. While initially utilizing areas of lesser wildlife value, the limited area for disposal will soon result in filling valuable wildlife habitat.

HUMAN ENVIRONMENT: SOCIAL AND ECONOMIC SETTING

Population in the study area is concentrated along the lower Cowlitz River, primarily in the incorporated communities of Kelso (11,000), Longview (30,100), and Castle Rock (2,140) (1983 populations), and the unincorporated community of Lexington. Over fifty percent of the population of Cowlitz County lives in Kelso and Longview, on opposite sides of the Cowlitz River.

Land use in Longview consists of valuable high density residential and commercial development within the city limits, with large areas of industrial activity located in the leveed flood plain of the Cowlitz and Columbia rivers. In Kelso, single family residential is the largest land use, with a small amount of land in commercial use. Castle Rock and Lexington land use is mainly residential; the remaining rural flood plain provides areas for agriculture, dredged material disposal, and for a minor amount of industrial activity.

The lower Cowlitz valley is a segment of a major transportation corridor. It contains Interstate Highway 5, the major route for the vehicular traffic between Portland, Oregon, and Seattle, Washington. The Burlington Northern and Union Pacific railroad tracks carry an estimated 22 trains per day, including both freight and AMTRAK passenger trains. These transportation routes are vulnerable to damage by flooding where their bridges cross the Toutle River near its confluence with the Cowlitz.

The economy of Cowlitz County is based on manufacturing industries, with the lumber, wood products, and paper products industries the most important. Retail trade, services, and government are the next largest sectors of the economy. The Kelso-Longview area is the largest center of industrial activity and employment in the County.

Unemployment rates in Cowlitz County have steadily increased since 1974. This trend reflects a loss of jobs in the forest products industries, partly because of cyclical fluctuations in the national home building industry. In recent years, however, timber supply, export competition, shifts in markets, and mechanization have contributed to a structural rather than a cyclical decline in the number of persons employed in the forest products industry. The depressed logging and forest products industries are believed to be the primary reasons for a net out-migration of population from Cowlitz County in the past several years. The after-effects of the eruption of Mount St. Helens and fear of recurring future eruptions may have contributed to the out-migration, but not as much as the absence of jobs.

A primary concern among the residents of the lower Cowlitz valley is the possibility of flooding and the disruptions to personal and financial well-being which could result. The possibility of flooding in this area is considered to be a real threat to life and property. The effects of flooding are well-known to residents of the lower Cowlitz; floods have been a recurring problem since settlement of the valley more than 100 years ago. The Corps of Engineers repaired and improved levees after major flooding in 1933, 1953, and 1956; and local diking districts have responsibility for maintaining them. Prior to the May 18, 1980, eruption of Mount St. Helens, the flood protection along the lower Cowlitz was estimated at the 500-year level. After the eruption and mudflows, the level of protection dropped to a 100-year level and in some cases to levels much lower.

Since the eruption, the potential for flooding has been kept in the public eye through news reports in the media, public meetings in connection with preparation of the Toutle-Cowlitz Watershed Management Plan by Cowlitz County and the Corps of Engineers Comprehensive Plan, and the periodic dredging and sediment removal activities on the lower Cowlitz and Toutle Rivers.

Dredging work since the initial eruption has left huge mounds of dredged material in the lower Cowlitz floodplain, visible reminders of the continuing flow of material eroded from the debris avalanche on Mount St. Helens. The temporary increases in levee heights in some areas created physical barriers and access problem for local residents. Examples are the concrete stoplogs on the

Longview levee across the main entrance to the Hall of Justice, and stoplogs which separate condominiums from their parking garages. While most residents view these features as beneficial in protecting property and lives, some homes are situated between the levee and the river. Cowlitz Gardens, a North Kelso neighborhood, is such an area. Thirty-six residences, located on the river side of the nearby levee, are at risk from flooding.

A flood warning system has been developed to minimize the potential for loss of life in the event of major flooding. If flood warning becomes necessary, the County Sheriff's Office and Department of Emergency Services will use a combination of several elements of the system. Elements of the system include sirens, patrol cars travelling pre-assigned routes with public address systems, and radio and television bulletins. This system is designed to provide warning in remote areas as well as in the urban centers, and the public has been well informed of the warning signals and evacuation routes. Confidence in the effectiveness of this system in protecting lives appears high among residents.

Recreation opportunities associated with the Toutle and Lower Cowlitz Rivers have been greatly diminished by the mudflows, continuing sedimentation, and sediment removal and disposal activities, all resulting from the eruptions of Mount St. Helens. The devastation caused by the volcano, however, has become an attraction for visitors to the area. To provide an opportunity for the public to view the remnants of these volcanic events, State Highway 504 has been reconstructed up the valley of the North Fork Toutle River to the N-1 debris retention structure. Cowlitz County has provided a parking area and visitor information center at that site, with some tourist facilities operated by concessionnaires. An estimated 200,000 tourists visited this facility during 1983.

The Forest Service plans to develop a permanent interpretive center 5 miles east of Interstate Highway I-5 on Highway 504 at Seaquest State park. This facility is scheduled for completion in 1985 and will provide a full range of interpretive information. The Forest Service estimates that over 800,000 persons will visit this facility each year. The Forest Service is also developing a Comprehensive plan for management of the Mount St. Helens National

Volcanic Monument (NVM) established by Congress in 1982. Most of the alternative plans being considered include access by State Highway 504 to planned visitor facilities on the west side of the NVM.

HUMAN ENVIRONMENT: CULTURAL RESOURCES

Research on prehistoric Native Americans identified three sites within the study area. Two sites (a village and burial area) are located within 2 miles of the confluence of the Toutle and Cowlitz Rivers. A third site (suggesting implement production) is located in an upland setting in the vicinity of Hollywood Gorge. These archeological sites offer support for the ethnographically identified subsistence pattern of the Salish Cowlitz Indians' use of uplands for hunting and gathering, and the lowlands for village sites. These villages were situated near fishing areas on the Cowlitz River. It is likely that Sahaptin speaking Indians also seasonally exploited areas on the upper Toutle basin (North and South Forks, Spirit Lake and the Mount St. Helens vicinity) with the Salish Cowlitz. Because of the limited cultural resource data for the Toutle drainage, the extent of upland use over time and specific sites are unknown. Consequently, background research into Native American activities in the study area suggests certain uses rather than identifying specific activities and sites.

Hudsons Bay Company trappers exploited the fur resources of the study area, becoming the first Euro-Americans to visit the Toutle basin. Historical sources indicate that settlement of the Toutle basin occurred in the 1880s. Homesteading did not take place before this time because of better agricultural land available along the Cowlitz River. Moreover, the lack of roads limited access to the Kid, Green River, and Toutle valleys. Early maps indicate travel was limited to a broken trail system generally following the ridge lines and main river drainages. Most homesteads contained only 10 to 20 acres under cultivation, small orchards, and the necessary homes and outbuildings. By 1910, all of the land suitable for agricultural purposes had been claimed. Small-scale dairy production or forage and hay crops developed over time as the chief agricultural pursuits. Another important economic activity for the early settlers involved cutting and floating cedar bolts to market. Most of

the early settlers were Swiss, Germans, Scandinavians, and Canadians. Of the original homesteading families along the North Fork of the Toutle, only one has remained in the valley to the present.

Logging first began south of the Toutle River on Ostrander Creek in 1887. Within the study area, the Northern Pacific Railroad had sold most of its land grant timber lands to the Weyerhaeuser Lumber Company in 1900. By the late 1920s, the Weyerhaeuser Company had acquired nearly all of the remaining timber lands in the Toutle Basin. After World War II, the Weyerhaeuser Company developed an extensive rail and logging road system to carry out its operations.

To the east of the study area, mining for gold, silver, copper and sulfur began in the 1890s and continued until World War I. Mining locations included sites near the headwaters of the North Fork Toutle River, and the northeast edge of Spirit Lake, the north and south slopes of Mount St. Helens, and the Green River drainage. The monetary value of the mining claims proved insignificant, as the metal-bearing ore was not present in commercially valuable quantities. However, miners did extract significant amounts of sulfur near the summit of Mount St. Helens until World War II.

IV. ENVIRONMENTAL EFFECTS OF ALTERNATIVES

PHYSICAL ENVIRONMENT

No Action

Toutle River. Sediment yields from the debris avalanche are expected to remain high throughout the 50-year project life. Ongoing changes occurring in the avalanche wil gradually reduce the rate of erosion, but the Toutle River Basin is expected to remain the most rapidly eroding watershed of its size in the United States.

The processes of bank downcutting and new channel formation contribute sediment to the flow, and existing channels undergo periods of scour and aggradation. Eventually these channels will become lined with cobbles as the finer materials are eroded; this armoring indicates the emergence of stability. Erosion will continue until drainage patterns stabilize.

The timing of sediment movement--how much is transported at a given time--is dependent on the intensity, duration, and timing of storms. The total amount of sediment affects the system in various ways. First, sediment transport varies exponentially, not directly, with increases in water discharge. Thus, streamflows following major storms carry many times the amount of sediment of flows generated by smaller storms. Second, storms often occur in series in the Pacific Northwest. When this happens, the rivers are not able to move sediment delivered by the first storm through the system before the second storm presents an additional volume of sediment. Two storms in 1982, for example, delivered nearly 11 mcy to the lower Cowlitz within four weeks.

In the North Fork Toutle River, the gravel and larger size classes settle out; the steep gradient and greater flow velocity of the stream make it an efficient transporter of sediment, and much of the sand and fine particles delivered to it pass on downstream. Carrying a heavy sediment load, the bed of the Toutle shifts radically; during a single storm, the amount of fill can be measured in tens of feet. Most of the changes in the main stem of the Toutle

have occurred in the lower gradient reaches of the stream. At these locations, considerable deposition has caused braiding, a condition that can double or even triple a river's width. As the river braids and widens, it attacks and erodes its banks.

Cowlitz River. The lower Cowlitz has less capacity for sediment transport than the Toutle; the low gradient and slower flow velocity cause sand-size particles to settle out. As the channel is filled in by sediment, the river will develop a braided pattern as aggradation changes the channel cross section from one of narrow, deep form to a wide, shallow cross section. Braiding occurs as an overloaded stream reach adjusts to pass the sediment carried to it from upstream. Braiding is caused by the formation of bars, dividing the flow into multiple streams which rejoin and subdivide repeatedly.

Deposition in the Cowlitz River would average 5 to 6 mcy per year for the immediate future. This would cause a continual increase in water surface elevations and expose all areas along the lower 20 miles of the Cowlitz River to the threat of annual flooding. The annual rate of deposition would gradually decline as the trapping efficiencies and incoming sediment loads decreased. The total accumulation in 20 years would be about 78 mcy.

Columbia River. Sand discharge from the Cowlitz River will have the potential for depositing in the Columbia River navigation channel in the vicinity of the Cowlitz/Columbia confluence for the entire 50-year study period. Annual deposition rates are projected to range from 6 mcy initially to 2 mcy in 50 years. The problem is expected to be most severe during the first 10 years, when the predicted erosion rates on the avalanche and Toutle River are highest. Deposition in the Columbia would only be a problem during the winter, when Columbia River flows are low and storms in the Toutle River basin produce large volumes of sediment. The Columbia could scour most of the deposition during its spring freshet, but that would be several months too late to prevent disruption of navigation. Additional dredging would be required to maintain the Columbia River navigation channel.

Base Condition

The base condition assumes continued interim dredging in the lower Cowlitz and Toutle Rivers. An estimated 113 mcy would be removed over the 50-year project life. Dredged material would be disposed of at sites in the lower Cowlitz and Toutle Rivers. Sites which have been identified as being suitable for disposal of material are shown in appendix D, exhibit 5 (plates B-1 through B-6). No determination has been made as to the availability of these sites.

An estimated 71 mcy would be removed from the Columbia River navigation channel. Disposal would occur at sites in the vicinity of Columbia River miles 68 to 71. The specific sites have not been selected at this time.

Limited Permanent Evacuation

This alternative would provide for removal of damageable property from the Cowlitz River flood plain above Kelso-Longview and would allow the processes of erosion, sedimentation, and channel stabilization to occur unimpeded. Removal of structures in the flood plain would increase the capacity of the lower Cowlitz to receive sediment deposits. Sedimentation would occur in the Columbia River, requiring extensive dredging to maintain the navigation channel.

Sediment Stabilization Basins

With this alternative, a series of three sediment stabilization basins on the Toutle River and North Fork Toutle River would reduce the amount of sediment moving downstream into the lower Cowlitz and Columbia Rivers. When these basins, or sumps, are excavated in the river, shallow pools form reducing the flow velocity. Sediment settles out in the basin and is then removed to disposal areas by mechanical means, such as dragline, hydraulic dredge, backhoe or scraper.

Once disposal areas adjacent to the SSB's are filled with excavated material, additional deposits would have to be hauled to more distant sites. This would extend the physical impacts of the eruption to lands not otherwise affected.

Because SSB's have limited efficiency, not all sediment would be removed from the system before the Toutle River enters the Cowlitz. Physical limits exist on how much material can be handled by dredging equipment in a given period of time. Moreover, the sediment delivered by one storm might equal or exceed the capacity of the basin. Because storms in this region often occur in series, a second storm could bring another wave of sediment before the basin could be dredged. Even if all three sediment stabilization basins operated continuously, only part of the sediment being transported could be trapped and removed with average flow conditions. Deposition of sediment in the lower Cowlitz and Columbia Rivers could necessitate additional dredging and disposal of material at downstream sites.

Multiple Retention Structures With Dredging

With this alternative, retention structures would be constructed along the Toutle and North Fork Toutle Rivers. Dredging operations behind the structures would remove the sediment to adjacent disposal areas until filled. Cowlitz and Columbia River dredging would also be required. Multiple retention structures with dredging are essentially enhanced sediment stabilization basins. They could retain slightly more material in storage to lengthen the time during which dredging could be performed, and they would be slightly more efficient than SSB's under low and moderate flow conditions. The amount of available onsite disposal area would be reduced somewhat because of the pool behind the retention structures.

Multiple Retention Structures Without Dredging

This alternative proposes a series of retention structures located along the Toutle and North Fork Toutle Rivers that would trap and permanently retain all future material eroded from the debris avalanche. These structures would remain in place once maximum sediment retention had been achieved.

These structures would be designed to pass river flows while capturing sediments. Some ponding of water would occur. Staging of construction is a possibility, particularly at upstream sites. This would allow construction in increments, raising the height of the dam and spillway as sediment fills in behind the structure.

This alternative would permanently alter the topography of the Toutle and North Fork Toutle Rivers. These structures and the sediment captured behind them would create a series of plateaus and waterfalls which would remain permanently in place.

Single Retention Structure

This alternative entails constructing a single retention structure (SRS) on the North Fork Toutle River with enough storage to trap most of the material projected to erode from the debris avalanche. Downstream dredging would be necessary to remove material below the site and sediment passed downstream during construction.

Sediment retained behind the structure would permanently fill in the existing streambed and floodplain of the North Fork Toutle River. High turbidity levels and channel instability would continue for prolonged periods in the sediment impoundment area. Once maximum sediment retention is achieved, channel stability could occur across the plateau of impounded sediment.

Ponding of water would occur behind the retention structure. Streamflows would pass through the outlets, with pools forming from larger storm events. Water temperature increases in these pools would occur, depending on the retention time of the stored water. Significant heating is not expected to occur as long as the retention time is less than 30 days. Surface water released after 30 days would be expected to increase 7° to 9°F above inflow temperatures. Once released, significant heat dissipation will occur because expected turbulent conditions would create a good air/water interface during the daylight hours. Also, night air cooling would increase heat removal from the water. Most of the heat is expected to dissipate during the first 24 hours following the release of the water.

A stilling basin will affect the water quality of the Toutle River downstream of any structure. During the water year's low flow period, July through September, a secondary impoundment would be created by any stilling basin downstream of the structures. If turbidity levels are not a limiting factor, stilling basins will tend to slow down the water velocity and provide a site for increased bacterial and algal productivity. This will not occur if turbidity levels are high and block sunlight needed for growth. The proposed Green River site regulating outlet does not discharge into the stilling basin. The LT-3 and Kid Valley sites do. The Green River stilling basin will probably be a closed system without any purging flows during the summer months. This situation may cause esthetic water quality problems, such as algal blooms visible to observers. Potentially, it could cause public health problems by creating an environment suitable for undesirable bacterial growth. The stilling basins would be flushed by the first major storm of each water year. It is anticipated that after that flushing the bacterial and algal material would no longer be a water quality problem at the debris retaining structures or in the Toutle River.

A secondary impoundment would also be created downstream without any stilling basin. The plunge pool immediately downstream of the debris structure would also act as a mixing tank during the low flow period. This water would tend to provide a site for bacterial and algal production. Flushing would only occur during and following the first major runoff event of the new water year. Other energy dissipation schemes, such as a flip bucket, will not be important factors during significant periods of water quality concern. Low summer and early fall flows will not be affected by a flip bucket.

Downstream of the structure, dredging in the lower Toutle River would continue to be required for two years, decreasing as channel stabilization and revegetation occurred. With the material from the debris avalanche retained in the upper Toutle valley, physical and biological recovery of the lower river would occur at a greatly increased rate compared to no action conditions.

Three sites were identified as suitable for an SRS. The Green River site is located on the North Fork Toutle River upstream of the Green River confluence at approximately RM 13. The Kid Valley site is on the North Fork Toutle River downstream of the Green River confluence at RM 6.9. The LT-3 site is on the Toutle River at approximately RM 9.5.

An SRS at the Green River site would create an impoundment area of 3,267 acres. Up to 299 mcy would be retained over the 50-year project life. The Kid Valley SRS could retain a maximum 463 mcy, covering 7,800 acres. The LT-3 SRS could retain a maximum 147 mcy, covering 1,030 acres.

BIOLOGICAL ENVIRONMENT: FISHERIES

No Action

Toutle River. If no action were taken, fisheries habitat would recover naturally over a long period. The rate of recovery is dependent upon the degree of initial impact, the period of continued disturbance, and other conditions. Recovery would proceed naturally, with no man-made structure blocking fish passage to upstream spawning habitat. Populations of fish following natural recovery would be lower than those before the eruption, since hatchery production accounts for about 70 percent of salmon and 60 percent of steelhead from this basin.

Recovery of fish production in the basin will be highly variable, depending upon the area, and the chronology of recovery remains highly conjectural. The degree of initial impact is an important factor affecting recovery. For example, North Fork Toutle, where the majority of the natural fish production occurs, is seriously affected by the debris avalanche and will take longer to recover than streams which received only ashfall.

The period of continued disturbance will further affect the time necessary for recovery. As described in the sediment section, the North Fork Toutle will be the longest in recovering from sediment movement (35 years). On the other hand, sediment movement from Green River and South Fork is subsiding presently.

Reduction in stream temperatures and establishment of instream cover also affect recovery timing. These factors are related to the recovery of riparian vegetation. For small streams, riparian trees over 12 feet high are needed to provide shading which reduces summer water temperature to tolerable levels. Tree growth rate data for Mount St. Helens mudflows soils indicate 5-6 years would be required for red alder to reach this height. Mudflow areas are recolonizing faster than debris avalanche areas where revegetation has not begun. Instream cover provided by large organic debris, such as trees, are also necessary for complete habitat recovery. Tree growth data indicates that 50- to 75-year-old trees, growing on mudflow soils will be necessary to provide this large organic debris. Larger main stem rivers such as the North Fork Toutle will require trees not available for at least 75-100 years. These growth times would be lengthened by the period of time needed for vegetation to initially reestablish. Outside the National Volcanic Monument, however, projects are currently underway to provide large organic debris to streams.

Based upon these factors, the following events are expected to occur. Streams affected primarily by ashfall, which include many of the small tributary streams, would reach full production within 10 years. While much of the Green River and South Fork already have some production, the reduction of sediment yield and eventual reestablishment of riparian vegetation would bring full recovery within 15 years; State fishery agencies estimate 1987 for the South Fork Toutle and 1992 for the Green River. For the lower North Fork Toutle River, recovery based upon reduced sediment yield is expected within 35 years. For the upper North Fork Toutle River on the debris avalanche, total recovery might not be seen for 75 years. With the no-action alternative, then, we would see a slow and gradual reestablishment of natural production of anadromous fish. An estimate of this recovery above the Green River site is shown in figure IX-1. This figure, based on recovery estimates provided by the resource agencies, shows catch plus escapement of returning adults

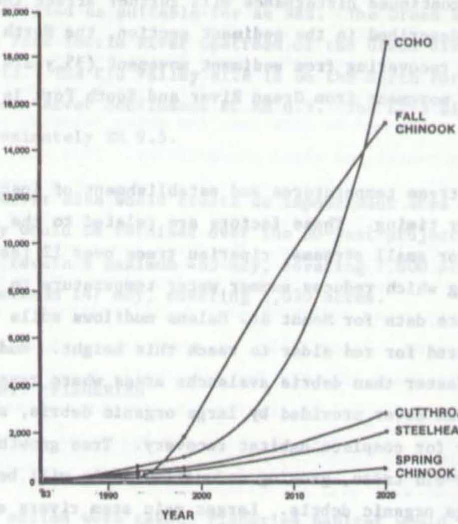

Figure IX-1. Estimated Fish Production Recovery above Green River Site

contributed by natural production above the Green River single retention structure site. This also shows limited natural production currently occurring in the North Fork Toutle River.

Cowlitz. The Cowlitz River would continue to be influenced by continual sedimentation. It would not provide any spawning or rearing habitat and would continue to present turbidity and migration problems until sediment input subsides.

Columbia. While the eventual impact of large quantities of sediment entering the Columbia and estuary remain uncertain, the operations necessary to maintain the Columbia River navigation channel will result in negative fishery impacts. The lack of environmentally sound disposal areas for the millions of yards of dredged sediment will require the use of upland sites that provide

valuable detrital input to the Columbia system, as well as inwater fills in locations that provide valuable fish rearing areas.

Base Condition

Upstream of the sediment stabilization basins, fish habitat recovery would be similar to the no-action alternative. However, continued dredging in the lower Cowlitz and Toutle Rivers could have adverse effects on fish passage by creating additional turbidity and other hazards to fish during migration. The retention of sediment heading for the Columbia would have a beneficial effect on fish in that river.

Limited Permanent Evacuation

Toutle River. The effects of this alternative on fisheries in the Toutle River Basin would be the same as the effects of the without-project condition. No structural measures or dredging would be done in the Toutle River or its tributaries, permitting natural recovery processes to occur. Recovery is related to the time required for the sediment load to diminish and reestablishment of riparian habitat.

Cowlitz River. Under this alternative prolonged turbidity would occur in the Cowlitz River as material from the debris avalanche is eroded and carried downstream with deposition occurring in the abandoned or undeveloped portions of the flood plains of the Cowlitz and Columbia Rivers. This would have detrimental effects to fish migration, spawning, and rearing in the lower Cowlitz River.

Eventually, the rate of erosion and sedimentation would decrease, and water conditions in the lower Cowlitz would improve. Riparian vegetation would reestablish, providing streamside cover and a food source for insects. Over the long term, new habitat would be created for resident fish and rearing salmonids as the Cowlitz River meandered and formed new channels, backwaters, and oxbows in the sediment deposits.

Columbia River. This strategy would have no effect on the long-term sediment yield to the Columbia River. The effects of this approach would be the same as those described for the without-project alternative.

Sediment Stabilization Basins

Toutle River. With SSB's, the upper Toutle River would remain accessible to anadromous fish. During the life of the project, turbidity levels would remain high, especially in the SSB's during sediment removal. This would be detrimental to fish passage, as would the actual removal operations. These effects could be mitigated by scheduling removal activities to avoid periods of major fish migrations, although the quantities that would require dredging might not allow this mitigative action. Since the sites of these SSB's are in the main stem and North Fork Toutle River, fish runs would be affected not only in the North Fork Toutle but also the South Fork Toutle and Green River basins.

There would be continued disturbance to the riparian area and streambed at the three SSB sites during the life of the project. There would also be little or no spawning and juvenile rearing at the SSB sites that extend over large areas.

Cowlitz River. Although the SSB's would reduce sedimentation of the Cowlitz River, dredging would continue to be required in the Cowlitz. Removal operations at the SSB's and dredging in the Cowlitz would contribute to high turbidity levels in the lower Cowlitz during the life of the project. The quantities of sediment requiring dredging would probably not allow a work stoppage during juvenile outmigration. This could impact upper Cowlitz River hatchery releases.

Columbia River. Sedimentation would continue to occur in the Columbia River with the sediment stabilization basins, although in lesser amounts than if no action were taken. This reduced dredging requirement would result in a corresponding reduction in impact to the fishery resource.

Multiple Retention Structures with Dredging

Toutle River. The four structures would block anadromous fish from the Toutle River. Although adults could be transported around the structures, they would be confronted by excavated areas where scrapers and/or draglines were operating. Fish bound for the South Fork would pass over two, and fish bound up the North Fork Toutle would confront four. Fish production would be lost during the operation period. After operation ceases, fish passage problems would continue at each of the structures. Dredged material would also impact fish habitat.

Cowlitz River. Sedimentation in the Cowlitz River would be reduced, improving the conditions for fish migration and expediting recovery. The dredging that would occur behind the retention structures would result in increased turbidity levels entering the Cowlitz. In addition, dredging in the Cowlitz would be required.

Columbia River. This alternative would substantially reduce the amount of bedload material entering the Columbia, resulting in less sediment deposition in the aquatic habitat. Additional dredging, however, would be required to maintain the 40-foot navigation channel.

Multiple Retention Structures without Dredging

Toutle River. Under this alternative, three debris retention structures would block anadromous runs of salmonids in the Toutle River. Sediment back-up behind these dams would inundate several tributaries and extensive reaches of the main stem and North Fork Toutle.

Cowlitz River. Dredging would continue in the Cowlitz River for several more years.

Columbia River. Fisheries in the Columbia would benefit from this alternative, as almost all sediment is retained in the Toutle River system.

Single Retention Structure

Toutle. The construction of a single retention structure at the Green River relocation will have the following major impacts on the Toutle River fisheries resource:

1. Blockage of fish movement
2. Inundation of spawning and rearing habitat, and
3. Downstream impacts.

A structure of this nature would totally block all upstream and downstream migration of anadromous fish if fish passage facilities were not incorporated into the design of this structure. Fish passage facilities are proposed (see proposed fishery bypass, chapter V). Providing these facilities would allow the continuing reestablishment of anadromous fish runs into tributaries above the SRS.

The backup of sediment behind the structure will inundate the streambed with sediment. For the North Fork Toutle, this inundation would not be significant since this stream is already subjected to sedimentation from the debris avalanche. However, the height of sediment backup will also affect tributaries that were not significantly affected by the eruption. Alder Creek, which currently provides productive spawning and rearing areas, will be inundated for four miles of its length.

The blockage of downstream sediment movement with this structure will result in rapid recovery of fish habitat below the structure; improved conditions will develop on approximately 17 miles of main stem Toutle River and 13.2 miles of North Fork Toutle River. Without additional sediment delivery, the sediment in the stream below the structure will erode and allow the reestablishment of a gravel bottomed stream with riparian vegetation supporting fishlife. This optimistic forecast of downstream recovery should be tempered, depending upon the quality of water released from the impoundment. As discussed in appendix D, the potential exists for impounded water to warm to such an extent that when released, its temperature would be detrimental to fish survival. However, with the minimum water impoundment

proposed, it is not anticipated that outflow water temperatures will be significantly different than inflow temperatures. Initial downstream dredging is also proposed as part of this plan. This operation would, however, be greatly reduced under the SRS alternative.

Since the Kid Valley site is below the confluence of the Green River and the North Fork Toutle, an SRS at this site would block valuable anadromous fish production on both streams. In addition, sediment backup from this site would inundate the Toutle River Salmon Hatchery, currently inoperable. The LT-3 site would affect an even greater extent of the Toutle River anadromous fish run, since almost all of the Toutle River Basin productive tributaries are above this location.

Cowlitz. The major factor affecting fish habitat in the Cowlitz River is the continuing sedimentation. This alternative, by reducing the amount of material delivered to the Cowlitz, would result in accelerated recovery for this stream from its mouth to the confluence with the Toutle, approximately 20 miles of stream.

Columbia. The great reduction of sediment entering the Columbia would reduce dredging operations and their impact upon the fishery resource. Filling of productive rearing habitat would not be required to meet disposal needs as might be necessary under the no-action alternative. Overall, this alternative would be very beneficial.

BIOLOGICAL ENVIRONMENT: WILDLIFE

No Action

To describe wildlife impacts simply and succinctly, requires focusing on wildlife habitat. The major component of habitat influenced by sedimentation and the alternatives under consideration is vegetation. By understanding how natural revegetation is impinged or what existing vegetation communities will be affected, wildlife impacts can be discerned.

Toutle. Wildlife habitat devastated by the eruption and debris avalanche is slowly recovering through natural revegetation to its pre-eruption state. The ability of vegetation to reestablish in the impact areas varies considerably from site to site. Simply, sites not impacted by the debris avalanche will recover rapidly, while debris avalanche deposits will recover slowly over a very long period. (This recovery scenario is described in greater detail in the Mount St. Helens Land Management Plan, USFS 1981.)

Relating the differing vegetation recovery rates and the value of differing plant succession to wildlife is a very complex analysis and found in some detail in the Coordination Act Report in exhibit 1, main report. Simply stated, however, the principal factor affecting Toutle River wildlife under the no-action alternative is the impact of sedimentation in retarding the recovery of riparian zone vegetation.

The on-going deposition of sediment in the Toutle River results in a continual meandering of this stream within the flood plain. This meandering results in the loss of the reestablishing riparian vegetation. The no action alternative would result in a long-term instability of the riparian zone of the North Fork Toutle and Toutle River.

Cowlitz. The recovery of riparian habitat along the river would be slow until sediment delivery is reduced to allow the river to stabilize.

While human habitation along the Cowlitz River has reduced the value of adjacent wildlife habitat, the remaining habitat available along this river would be greatly reduced with this alternative.

Columbia. To maintain and protect the Columbia River navigation channel has required dredging at the Cowlitz River sump. With this alternative, dredging would continue over a very long period, requiring large acreages for dredged material disposal. The lack of environmentally acceptable disposal sites at the mouth of the Cowlitz will require the use of areas of high wildlife value; wildlife losses associated with the loss of riparian and wetland habitats with this alternative would be significant. Losses of valuable wildlife habitat would total hundreds of acres under the no-action alternative. Figure IX-2 shows an example of one site where wildlife habitat would be lost.

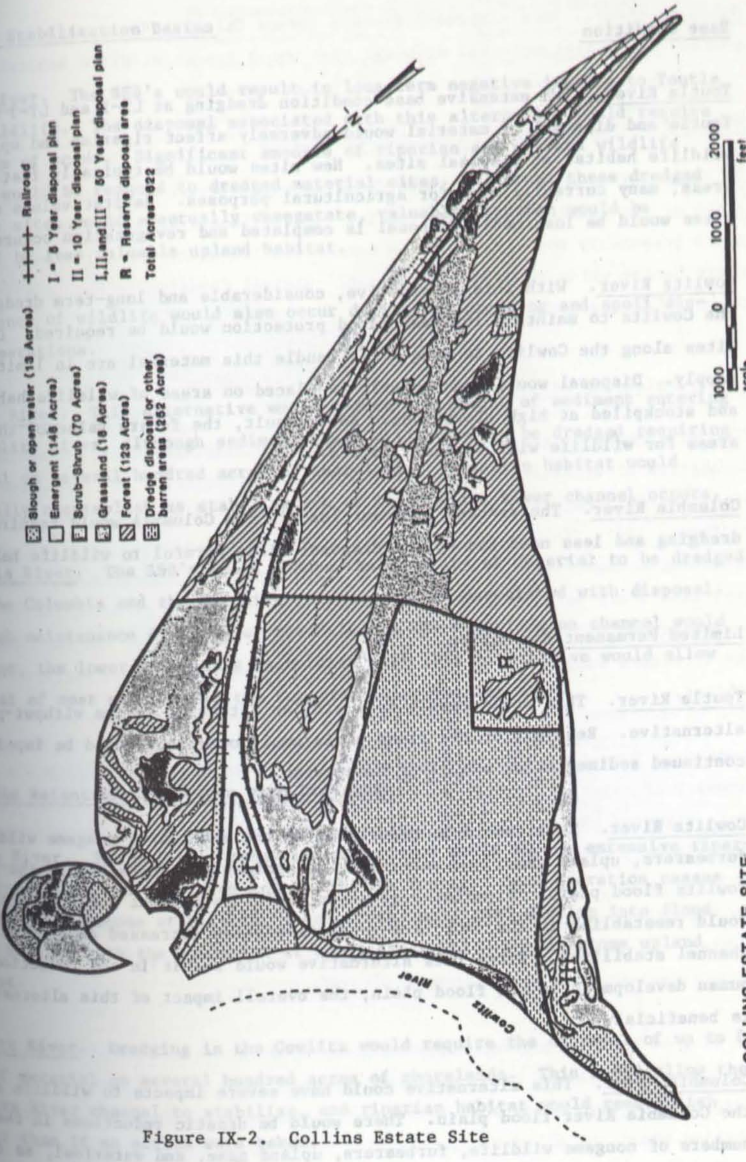

Figure IX-2. Collins Estate Site

Base Condition

Toutle River. The extensive base condition dredging at LT-1 and LT-3 on the Toutle and disposal of material would adversely affect riparian and upland wildlife habitat at disposal sites. New sites would be typically flat, open areas, many currently used for agricultural purposes. Habitat values at these sites would be lost until disposal is completed and revegetation occurs.

Cowlitz River. With this alternative, considerable and long-term dredging of the Cowlitz to maintain 100-year flood protection would be required. Disposal sites along the Cowlitz to adequately handle this material are in limited supply. Disposal would consequently be placed on areas of wildlife habitat and stockpiled at high elevations. As a result, the future value of these areas for wildlife will be very limited.

Columbia River. The reduced sediment load in the Columbia would require less dredging and less need for upland disposal sites harmful to wildlife habitats.

Limited Permanent Evacuation

Toutle River. This would result in a similar situation to the without-project alternative. Recovery of the flood plain would occur but would be impeded by continued sedimentation and river meandering.

Cowlitz River. There would be reductions in the numbers of nongame wildlife, furbearers, upland game, and waterfowl, as sediment is deposited in the lower Cowlitz flood plain. Riparian vegetation, wildlife habitat and populations would reestablish in the long-term as sedimentation decreased and the river channel stabilized. Since this alternative would result in the reduction of human development in the flood plain, the overall impact of this alternative is beneficial.

Columbia River. This alternative could have severe impacts to wildlife along the Columbia River flood plain. There would be drastic reductions in the numbers of nongame wildlife, furbearers, upland game, and waterfowl, as dredge spoils reduced wetlands/marshes and elevated lands.

Sediment Stabilization Basins

Toutle River. The SSB's would result in long-term negative impacts to Toutle River wildlife. The disposal associated with this alternative would require thousands of acres. Significant amounts of riparian and wetland wildlife habitat would be reduced to dredged material sites. Although these dredged disposal sites would eventually revegetate, valuable riparian would be replaced by less valuable upland habitat.

Disturbance of wildlife would also occur during the dredging and spoil disposal operations.

Cowlitz River. This alternative would reduce the amount of sediment entering the Cowlitz River, although sediment would still need to be dredged requiring disposal on several hundred acres of shorelands. Riparian habitat would eventually reestablish as stabilization of the Cowlitz River channel occurs.

Columbia River. The SSB's would reduce the quantity of material to be dredged from the Columbia and the wildlife-related impacts associated with disposal. Although maintenance dredging of the Columbia River navigation channel would continue, the lower quantities associated with this alternative would allow disposal of most material in the Longview-Kelso-Rainier area.

Multiple Retention Structures with Dredging

Toutle River. The multiple retention structures would impact extensive riparian areas along the main stem and North Fork Toutle. Once operation ceases and the pools become stabilized, these areas would then develop into flood plain habitat with the exception of spoil areas which would become upland habitat.

Cowlitz River. Dredging in the Cowlitz would require the disposal of up to 81 mcy of material on several hundred acres of shorelands. This would allow the Cowlitz River channel to stabilize, and riparian habitat would reestablish sooner than if no action were taken.

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Columbia River. This alternative would reduce Columbia River sedimentation, thereby minimizing material disposal that would impact wildlife habitat.

Multiple Retention Structures without Dredging

In the short term, an MRS without dredging would severely impact substantial areas of the Toutle River flood plain. In the longer term, however, these areas presumably would return to a marsh/riparian state and retain at least their former value as wildlife habitat. Minimal dredging in the Cowlitz and Columbia Rivers would be required.

Single Retention Structure

Toutle. The major affect upon wildlife of this alternative is the sediment inundation of wildlife habitat behind a single structure. For the Green River site, the sediment inundation area of 3,267 acres, by habitat type, is shown in figure IX-3. The major change would occur in types other than barren or disturbed revegetated; these two types, which comprise approximately half the area that would be inundated, would experience continued perturbation from sedimentation with or without the project. Once the fill of sediment behind the structure subsides, the area is expected to return to a marsh/riparian habitat.

Downstream from the structure, the reduction in sediment would allow the recovery of riparian habitat unaffected by continuous channel change. This area, figuring the area in the Toutle River flood plain yearly inundated, is approximately 1,770 acres.

The Kid Valley site would inundate approximately 7,800 acres of wildlife habitat. In addition, significantly greater areas would be affected by downstream actions associated with this plan.

The LT-3 site would inundate approximately 1,030 acres of habitat. However, the volume of material requiring disposal under this alternative is approximately four times that associated with the Green River site. This location would not allow the accelerated recovery of riparian vegetation in the Toutle River associated with the other two sites.

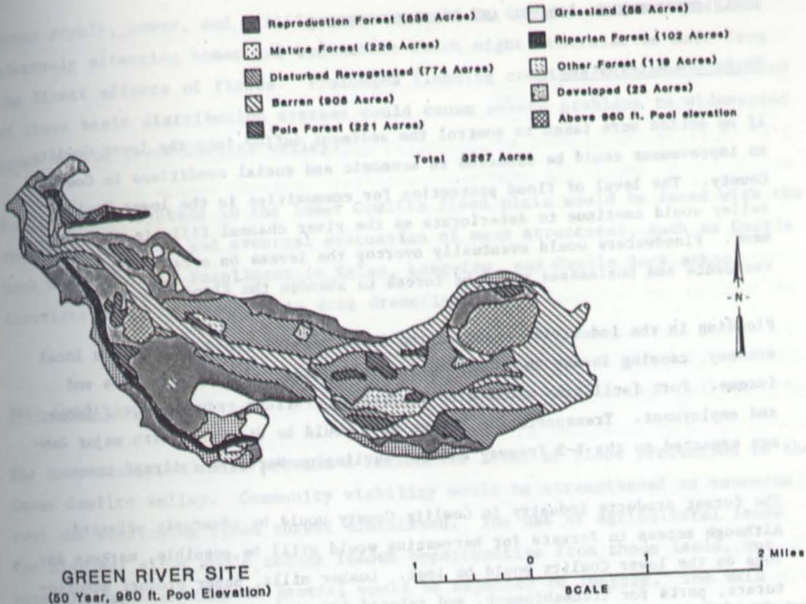


Figure IX-3. Inundation Area of Green River Site

<u>Cowlitz</u>. The reduction of sediment infill and dredging would be beneficial to Cowlitz River wildlife. The reduction in sediment delivery would allow the Cowlitz channel to stabilize and riparian habitat would reestablish sooner than if no action were taken. The reduction in dredging would also reduce the amount of wildlife habitat affected by dredged material disposal.

<u>Columbia</u>. The reduction of sediment would be beneficial in reducing wildlife impacts to the Columbia. The major disposal problem at the mouth of the Cowlitz with dredging of the sump would be reduced in extent; rather than needing to fill large disposal areas shown in figure IX-2, disposal would be limited to 15 mcy.

HUMAN ENVIRONMENT: SOCIAL AND ECONOMIC EFFECTS

No Action Alternative

If no action were taken to control the sediment inflow into the lower Cowlitz, no improvement could be expected in economic and social conditions in Cowlitz County. The level of flood protection for communities in the lower Cowlitz valley would continue to deteriorate as the river channel fills in with sediment. Floodwaters would eventually overtop the levees on a recurring basis; residents and businesses would be forced to abandon the flood plain.

Flooding in the industrial areas on the lower Cowlitz could disrupt the local economy, causing losses to manufacturing facilities and losses of jobs and income. Port facilities would also be damaged, further reducing local income and employment. Transportation in the area would be disrupted with major damage expected to the I-5 freeway and the Burlington-Northern railroad tracks.

The forest products industry in Cowlitz County would be adversely affected. Although access to forests for harvesting would still be possible, markets for logs on the lower Cowlitz would be lost. Lumber mills, paper product manufacturers, ports for transshipment, and related industries are all located on the Cowlitz delta. These industries would not be able to operate at their present locations because the area would eventually be flooded if no action were taken. As business relocated to other regions, the tax base would decline.

Population would be expected to decrease, as persons displaced by flooding look for homes in other areas. Increased unemployment due to flooding of industrial facilities would cause residents to look for opportunities in other locations.

Psychological stress experienced by residents would increase as the effects of flooding, feared for so long, become reality. Emergency relief services would be burdened with providing emergency food, shelter and medical care to persons displaced by floodwaters. Community viability would deteriorate as homes and business are lost to flooding, transportation systems are disrupted, and people leave the area.

Water supply, sewer, and utility systems would be damaged or destroyed, adversely affecting homes and businesses which might otherwise be safe from the direct effects of floods. Prolonged flooding combined with the breakdown of these basic distribution systems could cause severe problems to widespread areas of the lower Cowlitz valley.

Public school systems in the lower Cowlitz flood plain would be faced with the continual flooding and eventual evacuation of many structures, such as Castle Rock High School. Enrollment in Kelso, Longview, and Castle Rock school districts would be expected to drop dramatically.

Base Condition

The base condition would provide a reasonable level of flood protection to the lower Cowlitz valley. Community viability would be strengthened as concerns over the continuing flood threat diminished. The use of agricultural lands for disposal sites would reduce income opportunities from those lands, but economic opportunities in general would be expected to improve. The main impact of large disposal areas would be on tax base and land use, although new employment opportunities would occur.

Limited Permanent Evacuation

The viability of the communities in the evacuated area would be adversely affected. People would be required to abandon their homes in an area inhabited for more than 100 years. Castle Rock would be especially hard-hit; for it is an old, close-knit community. In addition, severe psychological and social stress often occur with displacement and relocation.

Community viability would also be threatened in the protected areas of Kelso-Longview. Restructuring the levees would require large land areas, and relocation of residences and businesses. Some of the more important industrial facilities would be affected by the levee raising, and might be forced to relocate if their access to the river were restricted or if their

activities were limited by a reduced land area. Loss of employment opportunities would adversely affect the economic and social well-being of Kelso-Longview.

Businesses in Castle Rock and Lexington would be severely disrupted or permanently closed during the relocation process. Jobs and income would be lost if businesses were to close rather than move. Some jobs might be created by activities associated with the evacuation, including new home construction, removal of abandoned houses and buildings from the flood plain, levee raising, and highway and railroad relocation.

Revenues to local governments would be reduced as homes and businesses were removed from the tax rolls.

Sediment Stabilization Basins

With this alternative, business and industry would be able to resume pre-eruption activities, making investments and growing as normal business factors permit. Growth in income opportunities would be expected. The long-term need to continuously remove sediment from the stabilization basins and to transport it to suitable disposal sites would generate some jobs. The use of agricultural or forest lands for sediment disposal sites would reduce income opportunities from those lands.

Community viability in the lower Cowlitz floodplain would benefit with this alternative because the threat of flood damages would be reduced. People would be more willing to remain in their existing homes and new businesses would be more likely to locate in the area.

Multiple Retention Structures with Dredging

This alternative would be beneficial to business and income opportunities by restoring flood protection to the area. The long-term need to remove sediment, and the phased construction of the retention structures would generate some jobs.

Multiple Retention Structures Without Dredging

Economic and social effects of this alternative are similar to those for the previous alternative, except that less labor would be required without the need for dredging. Thus, fewer jobs and income opportunities would be generated as a direct result of implementing this alternative.

Single Retention Structure

As described for the other structural alternatives, the flood protection provided by this alternative would help to restore favorable conditions in downstream communities, allowing business and commercial activities to proceed as normal business factors permit. Some jobs would be generated by construction of this alternative.

LT-3. An SRS at this site would require the removal of 13 homes or buildings along Tower Road. A portion of the Tower Road loop off of State Highway 504 would be inundated. Because residences would be removed, there would be no need to relocate the road or utilities. Downstream dredging would require use of agricultural and other lands for disposal. This alternative SRS would require the greatest amount of dredging of the three SRS sites.

Kid Valley. An SRS at this site would inundate residences, a state highway, a county road, the Green River fish hatchery, and utilities. SRS of various sizes would inundate the communities of Kid Valley and St. Helens. The smaller SRS would inundate State Highway 504, the county road for the community of Kid Valley, and power and telephone utilities. Up to 34 homes or buildings would require removal. Downstream dredging would require use of agricultural and other lands for disposal.

Green River. An SRS at this site would inundate the community of St. Helens, as well as the state highway, county road, and utilities. Nine homes or buildings would require removal. Downstream dredging would require use of agricultural and other lands for disposal. Disposal requirements would be approximately the same as for Kid Valley SRS alternative.

HUMAN ENVIRONMENT: CULTURAL RESOURCES

A cultural resource survey of the Green River single retention structure project area has been conducted. The survey did not result in the documentation of any significant historic or archeological sites. Commercial logging practices have obliterated the remains of the first homesteads, such as structures, cleared fields and orchards. Only oral tradition indicates the sites of early homesteads, schools, cemeteries, and post offices located in timbered areas. Isolated historic artifacts are present in the project area. These include square nails, a few fragments of early 20th century bottle glass, and a fireplace with chimney (a remnant of St. Helens post office and stage coach stop). Short-term homestead occupancy, repeated clearcut logging and slash treatment, and the effects of the Mount St. Helens mudflow account for the lack of substantial cultural resources. Results of the cultural resource investigation will be coordinated with the Washington State Historic Preservation office.

Cultural resource surveys of other alternatives have not been accomplished. If another alternative is selected, further investigation would be completed.

V. REVIEW AND CONSULTATION REQUIREMENTS

PUBLIC INVOLVEMENT

The Corps initiated public involvement by publication of a "Notice of Intent to Prepare an Environmental Impact Statement" in the 22 September 1982 Federal Register. In addition, a letter dated 12 September 1982 was sent to approximately 500 agencies, organizations, and individuals informing the public that an EIS would be prepared for the Comprehensive Plan. Both of these notices included a preliminary list of alternatives for the Comprehensive Plan. The letter also identified categories of environmental effects and asked for comments on significant issues to be addressed in the EIS. Comments received were used in developing the scope of the EIS.

These scoping notices stated that an EIS would be prepared as part of the Comprehensive Plan report. The Corps subsequently deferred preparation of the EIS when it determined that the findings of the Comprehensive Plan study should receive a more detailed analysis in a feasibility report.

The Comprehensive Plan report, released for public review in November 1983, described the five strategies for sediment control:

- o Limited Permanent Evacuation
- o Sediment Stabilization Basins
- o Multiple Retention Structures with Dredging
- o Multiple Retention Structures without Dredging
- o Single Retention Structure

During the months of November and December 1983, numerous meetings were held in the study area to present those strategies to the public. The public reaction to the strategies ranged from a preference for continuation of the current dredging program to recommendations for construction of a single retention structure on the Toutle River. The public sentiment expressed most often was to retain the material in the Toutle River. A large majority supported the single retention structure on the Toutle above its confluence with

the Green River. The exception was those people from the Toutle Valley generally opposed to any dams on the Toutle River.

The Governors of the states of Washington, Oregon, and Idaho, and the Community Consensus Position (which was signed by 39 representatives of local government, service and civic organizations) also expressed support for the single retention structure. The U.S. Fish and Wildlife Service also supports this strategy with provisions for fish passage. The U.S. Geological Survey indicated a preference to control sediment as close to its source as possible to minimize impacts of downstream sediment transport and stated a concern that a large increment of storage (100 mcy) should be provided on any structure as early as possible to accommodate the possibility of a major event.

Coordination with other government agencies, Federal, state and local, has been continuous since the initiation of the Comprehensive Plan study. Inter-agency meetings have been held at key points in the study to present findings and to receive comments. More frequent informal communication among staff members and management of concerned agencies has been an important aspect of this planning effort.

Copies of the Draft EIS were filed with the U.S. Environmental Protection Agency. Notice of filing was published in the Federal Register on 2 November 1984, beginning the 45-day public review period which ended on 17 December 1984. Copies of the EIS were sent to interested Federal, State, and local agencies, private organizations, and members of the public. Copies were also sent to local libraries. A Notice of Availability was prepared to inform the public that an EIS had been prepared, how to obtain a copy, and the beginning and ending dates of the review period. This notice was sent to a wide mailing list, and a press release was prepared for media use. A Public Meeting was held on 29 November 1984 in Longview, Washington to summarize the results of the Feasibility Study and EIS and to obtain the views of the public. A transcript of that meeting has been prepared and is available from the Portland District.

Copies of all written comments received during the 45-day review period, and our responses to those comments, are included in this report (Exhibit 2, Public Views and Responses). The majority of those comments were from local

governments and agencies and members of the public expressing support for the preferred plan and opposition to the proposal that state and local governments be required to share in the cost of implementation of that plan. Comments received from resource agencies, including Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Washington Departments of Fisheries and Game included comments addressing specific effects of fish and wildlife resources, mitigation for project effects on these resources, and sedimentation and water quality effects. All of the comments received have been considered in preparing the Final EIS.

Copies of this Final EIS have been filed with the U.S. Environmental Protection Agency, and are being sent to other interested Federal, State, and local agencies, private organizations, and members of the public. Copies have also been provided to local libraries. Comments on this Final EIS must be received within 30 days of announcement in the Federal Register that the document has been filed with the Environmental Protection Agency.

This Final EIS includes a Section 404 Water Quality Evaluation. The evaluation addresses the effects of in-water fills associated with the construction of the preferred alternative.

COMPLIANCE WITH ENVIRONMENTAL LAWS AND EXECUTIVE ORDERS

1. Clean Water Act of 1977. A water quality evaluation, as required by Section 404 (b)(1) of the Clean Water Act, has been prepared for the preferred alternative. This evaluation was included with the Draft EIS for public review and comment. Compliance with the Clean Water Act will be accomplished through the provisions of Section 404(r) of the Act.

2. Coastal Zone Management Act of 1973, as amended. Not applicable.

3. Endangered Species Act of 1973, as amended. The U.S. Fish and Wildlife Service has been consulted and a preliminary determination has been made that no threatened or endangered species would be adversely affected (see exhibit 1).

4. Fish and Wildlife Coordination Act. Fish and Wildlife Coordination Act Report has been received and is hereby incorporated by reference in the Environmental Impact Statement, see exhibit 1. This report has been coordinated with other Federal and State resource agencies.

5. Marine Protection, Research and Sanctuaries Act of 1972, as amended. Not applicable.

6. Cultural Resources. A cultural resources investigation of the project site for the preferred alternative has been completed. No significant cultural resource sites were identified within the project area; therefore no adverse effects to cultural resources are anticipated from the proposed project. Coordination of these findings with the State Historic Preservation Officer has been completed and concurrence received.

7. Executive Order 11988, Floodplain Management. The flood plain has been severely altered as a result of events following the 18 May 1980 eruption. Mudflows, continuing sediment deposition, dredging, and dredged material disposal have all combined to change the topography of the flood plain. These changes will continue to occur for decades if no action is taken to restrict sediment flows. Implementation of any of the alternative plans except the no action alternative would help to stabilize hydraulic conditions in the Cowlitz and Toutle Rivers and allow local authorities to develop plans to manage future use of the flood plains. At the present time, a building moratorium is in effect for the 500-year flood plain of the Cowlitz and Toutle Rivers.

8. Executive Order 11990, Protection of Wetlands. If no action is taken, continued transport and deposition of sediment will have severe impacts on wetlands in the lower Cowlitz and Columbia Rivers. Wetland areas would be filled both by natural deposition of sediment and by placement of material as river channels are dredged.

The impacts of the alternative plans are discussed in the Environmental Effects section of this EIS.

List of Preparers

Name	Discipline/Expertise	Experience	Role in Preparing EIS
David Kurkoski	Geography, Environmental Planning	Environmental Impact Assessment (6 years)	EIS Coordinator
Al Ramirez	Civil Engineering Water Resources Planning	Water Resources Planning (8 years)	Study Manager
Chuck Mason	Planning	Water Resources Planning (15 years)	Asst. Study Manager Plan Formulation
Robert E. Willis	Biology	Riparian Ecosystem Research, Wildlife Mitigation Planning (7 years)	Biological Effects
James Graham	Hydrology, Geology	Sediment Transport Studies (2 years)	Sediment Studies
Joseph Hise	Economics	Regional Economic Studies (11 years)	Economic Effects
Michael A. Martin	Archeology	Archeology (5 years)	Cultural Resources Studies
William F. Willingham	History	History (14 years)	Cultural Resources Studies

COWLITZ-TOUTLE FEASIBILITY STUDY

SECTION 404(b) EVALUATION

TOUTLE RIVER SEDIMENT RETENTION STRUCTURE

COWLITZ COUNTY, WASHINGTON

Introduction

Section 404 of the Clean Water Act requires that all civil works projects involving the discharge of fill material into waters of the United States be evaluated for water quality effects prior to making the discharge. This evaluation assesses the effects of the discharge described below using guidelines established by the Environmental Protection Agency under the authority of Section 404(b)(1) of the Act.

I. Project Description.

The proposed action is to construct a single retention structure on the North Fork of the Toutle River at approximately river mile 13.5. The site is two miles upstream of the Green River confluence.

II. Description of Section 404 Discharges

a. Single Retention Structure. The single retention structure would be a roller compacted concrete (RCC) gravity dam, with an ungated overflow spillway discharging into a stilling basin and multilevel intakes to provide flow and water quality control. The dam would be 177 feet above the existing streambed with a spillway height of 155 feet. The structure and sediment impoundment area would cover approximately 3,267 acres, and would be capable of retaining 299 mcy of sediment during the 50-year project life.

b. Diversion Dams. Upstream and downstream diversion dams would be constructed to direct river flows to the left side of the existing channel while construction of the RCC foundation and spillway complex are begun.

c. Bank Protection. Bank or shore protection would be provided at the project as needed to control erosion caused by either releases downstream or

wave action within the reservoir. Streambank protection would be necessary only at critical locations where potential erosion might affect a structural component.

d. Fish Collection System. A fish collection system is proposed which would include a water supply system, holding pond, and a fish ladder or trap. Although the specific details of the collection facility have not been defined, coordination with fisheries agencies indicates that some form of collection system would be desirable to collect returning adult salmon and steelhead.

e. Other Construction-Related Fills. As construction progresses, it is likely that other fills would be necessary for construction purposes such as haul road and bridge construction, culvert placement, bank stabilization, and stream diversions for access to borrow areas. Although specific locations and quantities of these construction-related fills are not known at this time, these are typical actions required in the process of constructing a major dam and reservoir project.

III. Physical Determinations

a. Physical Substrate Determinations. The proposed construction site is overlain by recent alluvium and mudflow debris from the 1980 Mount St. Helens eruption up to depths of 20 feet or more. Beneath these, deep glacial fill deposits overlie basaltic bedrock. These sediments consist of hard, subrounded to rounded gravels, cobbles and boulders with sand and some silt. The glacial deposits at the site are estimated to reach a maximum depth of 155 feet and average about 90 feet in depth across the 850-foot-wide site. These materials would be excavated to expose foundation rock at the sediment retention structure site.

b. Water Circulation, Fluctuation, and Salinity Determinations. River flows would be diverted during construction of the retention structure. As an example, one feasible plan for diversion would be accomplished in three stages:

1. Diversion to the left side of the existing channel while the RCC foundation and spillway complex are begun. The minimum diverted stream width would be 30 feet.

2. Diversion through three 12-foot-diameter steel pipes embedded within the RCC foundation. An upstream diversion channel with cofferdam would provide a water surface with a maximum of 40 feet of head on the multiple pipe.

3. Diversion through the completed regulating outlet complex along the left side of the spillway. The retention structure would have ungated multiple regulating outlets (RO). The RO's would be designed to pass flows for a 100-year event.

Once the retention structure is completed, the sediment deposit would begin forming at the upstream end of the reservoir pool as a delta or fan shape. Because of the extremely large sediment load, aggradation in the reservoir head area would develop quickly. As the sediment wedge continues to grow it would impede bedload movement causing additional deposition upstream. The growing deposit would further attenuate sediment movement resulting in deposition both in the reservoir and in the upstream streambed. After this the stream would respond by developing a delta deposit through which the channel would again develop a braided pattern characteristic of high sediment loading.

Streamflows would continue to pass through the regulating outlets, with pools forming from larger storm events. Summer water levels would be low; water storage volumes of less than 1,000 acre-feet would not be uncommon. At times the pool would resemble a dry lake with a river flowing through it to the low level outlets, although a minimum pool would always be maintained to prevent trapped sediment from passing through the regulating outlets.

c. <u>Suspended Particulate/Turbidity Determinations</u>. Construction activities would contribute to the existing high suspended particulate and turbidity levels in the Toutle and Cowlitz Rivers. The relative increases caused by these activities would be inconsequential given the existing extremely-turbid and sediment-laden condition of these streams.

Once construction is completed, changes would occur in downstream erosion and sediment transport processes. Water passing through the reservoir will lose much of its sediment load, restoring its sediment suspension and transport potential. Therefore, although sediment from the debris flow in the North Fork Toutle River would be trapped and retained, the materials deposited downstream would undergo a period of renewed intense erosion. Overall, however, downstream sediment transport and deposition would be substantially reduced by the sediment retention structure.

d. Contaminant Determinations. Construction of the sediment retention structure and related features would not result in the introduction of contaminants into the North Fork Toutle River. Rock and earth fill materials would be obtained from sources near the construction site. Concrete used for construction would be placed in dry, and precautionary measures would be taken to prevent water used in preparing, curing, or cleanup of concrete from entering the waterway without prior treatment.

e. Aquatic Ecosystem and Organism Determinations. The aquatic ecosystem at the project site was destroyed by the mudflows of the May 18, 1980 eruption of Mount St. Helens. Natural recovery of the physical and biological system has already began, but the process of recovery is expected to be slow, requiring 75 to 100 years for re-establishment of pre-eruption conditions. The effects of the sediment retention structure on the aquatic ecosystem would be primarily in the alteration of these processes over the long-term recovery period.

The retention structure would block the migration of anadromous fish to the upper reaches of the North Fork Toutle River and its tributaries and eliminate these upstream areas from future fish production. Sediment trapped behind this structure would cover the existing streambed of the North Fork Toutle River and portions of tributary streams. During the period of active erosion of the debris avalanche and deposition of sediment behind the structure, conditions for re-establishment of aquatic habitat upstream of the retention structure would be poor.

Downstream of the structure, stabilization of the stream channel would occur more rapidly. Sediment transport, deposition, and turbidity would decline over the short term, improving conditions for the re-establishment of spawning and rearing habitat in downstream areas. Riparian vegetation along the lower river would reestablish at a more rapid rate.

Mitigation to reduce adverse effects to fisheries is being considered in coordination with Federal and State resource agencies. The recommendations of these agencies are contained in the U.S. Fish and Wildlife Coordination Act Report, which is included as exhibit 1 of the main report.

f. Proposed Disposal Site Determinations. The suspended particles caused by the proposed work would be widely dispersed by river currents and would not cause any significant adverse environmental effects.

The placement of the fill material would not violate Environmental Protection Agency or State water quality standards except possibly for a short duration during construction activities. Use of fill material would not introduce toxic substances into surrounding waters.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. The recovery of the aquatic ecosystem would be affected by the proposed project to the extent described in paragraphs III.e. and III.h.

h. Determination of Secondary Effects on the Aquatic Ecosystem. Sediment retained behind the structure would permanently fill in the existing streambed and floodplain of the North Fork Toutle River. High turbidity levels and channel instability would continue for prolonged periods in the sediment impoundment area. Once maximum sediment retention is achieved, channel stability could occur across the plateau of impounded sediment.

Ponding of water would occur behind the retention structure. Streamflows would pass through the outlets, with pools forming from larger storm events. Water temperature increases in these pools would vary, depending on the retention time of the stored water. Significant heating is not expected to occur as long as the retention time is less than 30 days. Surface water released

after approximately 30 days would be expected to have increased 7° to 9°F above inflow temperatures. Once released, significant heat dissipation is expected because of turbulent conditions creating a good air/water interface during the daylight hours. Night air cooling would increase heat removed from the water. Most of the heat should dissipate during the first 24 hours following the release of the water.

Downstream of the structure, erosion of mudflow deposits would continue for two years and would decrease as channel stabilization and revegetation occurred. With the material from the debris avalanche retained in the upper Toutle valley, physical and biological recovery of the lower river would occur at a greatly increased rate compared to no action conditions.

IV. Findings of Compliance or Non-compliance with the Restrictions on Discharge

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. Alternatives, including no action, have been considered and are addressed in the Environmental Impact Statement. Alternatives considered included: limited permanent evacuation, sediment stabilization basins, multiple retention structures with dredging, and multiple retention structures without dredging. The proposed action, a single retention structure at the Green River site, has been determined the most economical and environmentally acceptable alternative which would fully accomplish the objectives of the feasibility study.

c. The proposed action is in compliance with state water quality standards.

d. The proposed action would not violate the toxic effluent standards of Section 307 of the Clean Water Act.

e. Use of the sites would not harm any species or habitats designated as critical, endangered, or threatened under the Endangered Species Act of 1973.

f. The proposed action would not result in significant adverse effects on human health and welfare or recreational, esthetic, and economic values.

g. Appropriate steps to minimize potential adverse effects on the aquatic ecosystem would be specified in the construction contract.

With the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem, the proposed discharge is specified as complying with the requirements of Section 404(b) guidelines.

CHAPTER X - DISCUSSION, CONCLUSIONS, RECOMMENDATIONS

DISCUSSIONS

General

The problems resulting from the 1980 eruption of Mount St. Helens are unlike any others experienced in the United States. In the 4 years since the eruption, the Federal Government has expended in excess of $300 million to minimize damage and property losses from flooding and to maintain the navigation channel in the Columbia River. Coincidental with these activities, the Corps has devised a long-term strategy to alleviate the continued threats to people, property, and transportation presented by ever changing conditions. The impossibility of predicting accurately what natural phenomena may still occur at Mount St. Helens has complicated the response. Nonetheless, every reasonable effort has to be made to provide protection against such unknowns. Further, the amount and timing of sediment movement are critical factors in evaluating any long-term solution. Our current knowledge does not permit exact determinations concerning these items, necessitating the use of a range of assumptions in planning. Continued close cooperation among Federal, State, and local agencies, as well as continued careful professional monitoring of the erosion process will facilitate adjustments to any programmed solutions.

The long-range problems resulting from the Mount St. Helens eruption separate into two general categories: The first set of problems is associated with a debris dam blocking the outlet for Spirit Lake in the upper reaches of the Toutle River. If the debris dam were to give way, a disastrous flood would result in areas below. The second group of problems concerns the massive amount of sediment deposited in the Toutle River watershed. This sediment has not stabilized and continues to be transported downstream, creating flood threats by blocking the lower reaches of Toutle and Cowlitz Rivers. Continuing deposition of a portion of this sediment in the Columbia River also adds to the cost of maintaining the Columbia River navigation channel.

The issues associated with the debris dam blocking Spirit Lake have been resolved and construction of a tunnel to control water surface elevations in

Spirit Lake is underway. Details on Spirit Lake options and the recommended plan currently under construction are contained in the Decision Document, dated February 1984.

The long-term solution to the control of sediment is complex. The amount of sediment which must be provided for, the timing of any movement that will occur, provisions for nonhydrologic events (mudflows), and assurance that any strategy implemented will not worsen existing conditions all cause great uncertainty. This Feasibility Report presents the best estimate as to the amount and timing of sediment movement under normal hydrologic events. However, notwithstanding the accuracy of predicting sediment movements and other events, any program should provide flexibility to adjust to actual conditions. The most difficult sediment movement to predict and provide for is associated with the intensity of future precipitation and the characteristics of resultant runoff. This aspect of the problem is most critical in the early years, because over time stabilization will lessen average sediment delivery.

Excessive precipitation, with attendant flood runoff before stabilization takes place, causes movement of large amounts of material which must be controlled in order to avoid downstream flooding and navigational hazards. Fortunately, no catastrophic or unusual events have occurred. Temporary solutions, involving dredging reaches of the Toutle and Cowlitz rivers (emergency action and PL 98-63) and constructing temporary structures and small retention basins have prevented flooding and interference with navigation since the 1980 eruption. These temporary solutions, while providing protection on an interim basis, are expensive to maintain and do not provide the long-term security necessary to the 50,000 residents of the Longview, Kelso, and adjacent areas.

During the Comprehensive Plan studies (1982-83), a study team screened several measures that could provide long-term security to Cowlitz River communities. The two most feasible alternatives involved construction of either a large single retention structure (SRS) or smaller multiple retention structures (MRS) at sites on the main stem and North Fork Toutle rivers. Accordingly, analysis during preparation of this Feasibility Report concentrated on these two alternatives.

Specific Issues

As the feasibility study progressed, it became apparent that certain issues affecting the final recommendation had to be resolved. Those issues are presented and discussed below.

- o Risks, costs, and benefits associated with staged SRS for sediment movements less or greater than the projected estimate.

The study analyzed the sensivity of the preferred plan to sediment delivery uncertainties and staged construction. That analysis concluded that if the projected sediment delivery is one-half that estimated, continued dredging becomes the preferred plan, provided one assumes the risks associated with abnormal rainfall or a mudflow. Similarly, staged construction of the preferred plan is less costly if sediment delivered is one-half the estimated amount and a full-height structure is not required. Again, the inherent risks associated with other than the average annual delivery rates are ever present during the early years of project life. A thorough discussion of factors involved in staged construction and associated trade-offs is presented in chapter VI of the report.

- o Documentation of assumptions used to formulate the base condition against which alternatives were measured to arrive at the best solution to the sediment problem.

Levels of protection provided by interim dredging under PL 98-63 (60 years at Longview, 20 years at Kelso, 30 years at Lexington, and 10 years at Castle Rock, November-December 1983) were examined to determine if that effort is justified. The annual cost of maintaining existing sediment stabilization basins on the Toutle River and dredging in the Cowlitz River ($23.3 million), when compared to damages prevented ($127.5 million), resulted in average annual net benefit of $104.2 million and justifying that activity. Further, this measure is shown to satisfy short-term protection needs until a permanent program can be implemented. Columbia River navigation is also insured through these actions. Details on establishment and justification of the base condition are in chapters III and IV.

- o Types and dollar value of damages that may occur under the base condition for various storm events (1/10, 1/20, 1/50, and 1/100) at various points in time (1984, 1988, and 1994) for various sediment yields (1/2 E, E and 1-1/2 E).

Flood damages associated with the base condition are directly related to flood events of various frequencies. The base condition dredging primarily removes average annual sediment deposits. Depending upon its severity, a storm event occurring at some point in time would cause damage uncontrolled by base condition dredging. As an example, had a once in 10-year frequency storm event occurred in November 1983 (established baseline condition), total damages, primarily in unleveed areas, would have amounted to $4,121,000. Damages would increase if a greater than 1-in-10-year event had occurred, with a 100-year event exceeding safe levee heights at all locations and producing estimated flood damages of $177 million. These damages would be similar in out years (1988, 1994) regardless of the rate of average annual sediment delivery. Complete descriptions of damages and a discussion of storm events are contained in Chapters III and IV.

- o Types and dollar value of residual damages from storm events of various frequencies (1/10, 1/20, 1/50, and 1/100) for 1984, 1988, and 1994 for various sediment delivery rates (1/2 E, E, 1-1/2 E) if emergency floodfight activities are implemented and temporary levees are maintained.

Although dredging activities to maintain the base conditions prevent an estimated $127 million in damages, some losses which could be prevented by other than dredging activities will still occur. The analysis examined reduction of damages through emergency floodfight activities.

Emergency floodfight activities would focus on evacuation of residents. The nature of storm events is such that insufficient mobilization time exists from the moment a flood event is anticipated and it actually occurs. Also, access to levees is severely restricted due to nearby dwellings and extensive urban development in areas adjacent to the permanent structures. Floodfighting activities would cost an estimated $26 million and would not reduce property damages significantly. The cost of evacuation is a preliminary number,

based on inhouse evaluation, and has not been coordinated yet with local emergency operation officials. Reduction of damages due to maintenance of the temporary structures is insignificant and would have no impact on enhancing the base condition. The foregoing is true for all storm events at any point in time, regardless of the rate of average annual sediment delivery. Details of the analysis are contained in chapter III of the feasibility report.

- o Comparative analysis of costs, risks and benefits associated with one-time construction of an SRS or staged SRS and dredging will be kept current.

Because of uncertainties with sediment delivery rates, a sediment monitoring program has been in operation since the 1980 eruption. As more data is gained from that program, better and more accurate sediment projections will evolve. During continued planning and engineering studies, that data will be used in final preparation of design documents to insure flexibility to meet changing needs.

Once the study determined the best projected sediment delivery rates, application of standard planning and project formulation procedures showed an SRS at Green River site on Toutle River as the most feasible solution. A 177-foot-high structure at that location, coupled with downstream actions (dredging), achieved the greatest net benefit when compared to the base condition and was selected as the NED plan. A sensitivity analysis of the NED plan reaffirmed its capability to accommodate the expected sediment delivery rate (299 mcy) under average conditions for the 50-year project life. Further analysis indicated the NED plan also provided sufficient storage to accommodate both the 100-year storm event (14 mcy sediment load) and a design mudflow (75 mcy) during the early years of the project, when such storage capacity is most critical. Beyond the initial critical years, sediment delivery begins to diminish and storage for abnormal events is less a factor. Accordingly, the NED plan is the preferred plan. Details on the NED plan are contained in chapter V of the Feasibility Report.

- o Resolution of the need for relocation of State Highway 504

A major portion of the original right-of-way of State Highway 504 lies within the proposed project area. It provided the general public access to the Spirit Lake recreational areas, as well as serving the needs of private and state agencies in the general area. The mudflow at the time of the original eruption of Mount St. Helens destroyed the old highway in the general area of the proposed project. This highway was partially reestablished on a temporary basis as shown on plate 22, appendix D.

The State will determine if reestablishment of State Highway 504 is necessary to serve the public's interest and to promote continued regional economic growth. The initial corridor alinement goes through the Green River site up to Coldwater Lake. This alinement utilizes a portion of the existing temporary route of State Highway 504 in this area. The alinement was developed based on the economic costs of rights-of-way, construction, and continued maintenance. Funds for the route, if approved, would be available to the State from emergency monies provided by the Federal Highway Administration. Funds are currently available and reserved for the State of Washington for this specific replacement. The State has started planning efforts and could finalize the construction plans for the realinement of State Highway 504 upon establishment of the public need.

A portion of the highway realinement falls within the proposed project boundary and will be affected by the construction of the Green River structure and its subsequent debris retention area. Studies indicate that the next most economically feasible alternate route which bypasses the project area would increase the cost of highway replacement by an estimated $4,300,000. This increased dollar amount is not available to the State under the existing Federal Highway Administration funds of $18 million.

Should the State of Washington establish a continued public need for State Highway 504, the additional costs associated with the proposed relocation would be considered an appropriate project feature cost and would require approval and authorization.

CONCLUSIONS

1. The potential for flooding in communities along the Cowlitz River, damage to the transportation corridor, and impacts to navigation on the Columbia River require implementation of permanent measures to manage the risk created by the movement of sediment.

2. Based on the analysis performed during this study, a plan consisting of a single retention structure at Green River and supplemental downstream actions best meet the objective of developing a long-term plan to deal with flood and navigation problems resulting from the Mount St. Helens eruption. This plan also achieves the highest economic efficiency consistent with preservation of life and property and most effectively deals with variations in quantities of sediment delivery.

3. What we now know about the sediment budget, as presented in this report, shows a need for immediate action. Any delay in the construction of a permanent solution only increases the flood risk in Cowlitz County and commits the Federal Government to potentially greater expenditures.

4. Coordination with nationwide experts in the field of sedimentation indicates that reported sediment predictions reflect the experience of the last four years. Because of the uncertainties associated with volcanic and hydrologic events, we will continue to learn more about sediment deposition over time and the associated risks.

5. The Congress has established a Federal role in flood damage reduction. However, the flood problems stemming from the after-effects of the Mount St. Helens eruption created a unique situation. As a result, past Federal emergency efforts and the Presidential commitment to respond to any future life or property threatening emergency lay the foundation for a Federal role in the Cowlitz and Toutle rivers. The Federal responsibility in navigation is based on the existing authorized navigation project for the Columbia River.

6. A single retention structure at the Green River site has less impact on fisheries when compared with other alternatives. However, it will impede fish passage into the upper Toutle above the structure. Initial design and construction considers facilities for fish passage using trap and hauling methods. All costs associated with the construction of the fish passage facilities should be a Federal responsibility. No other mitigation is found to be justified.

7. Requirements for annual sediment removal by downstream dredging should be analyzed each year, through the plan's sediment monitoring program.

8. During the next several years no matter which alternative is selected for expedited implementation as a permanent solution, dredging will continue and additional insight will be obtained about the rate, and likely future magnitude of sediment deposition. Therefore, the comparative analysis of risks, benefits and costs, and design, at an equal level of detail, of one-time construction of an SRS, staged SRS, and dredging will be kept current during the continued planning and engineering phase and will respond to new information. Adjustments to the preferred alternative will be made as may be indicated by current data and another solution may be selected if there are compelling and convincing reasons for so doing.

9. No provisions should be made that preclude raising a completed structure above the preferred height if future conditions warrant.

10. This Federal project should be exempt from the imposition of all Washington State and local sales, use, and associated excise taxes (Title 82 of the Revised Code of Washington) on the value of the services and materials provided under Federal contracts and subcontracts.

The recent decision of the United States Supreme Court in Washington v. United States, 103 S. Ct. 1344 (29 March 1983), held that the State may impose such taxes on Federal contractors unless the Congress specifically exempts contracts arising under a particular Federal program. Such an exemption should be provided by Congress in this instance. In any event there should be assurance that the limited monies allocated for the authorized program are actually spent only to provide for the specific benefits identified in this report.

RECOMMENDATIONS

After careful consideration of the environmental, social, and economic impacts of alternatives for controlling sediment deposition in the Toutle, Cowlitz, and Columbia Rivers, I recommend that the Secretary of the Army, acting through the Chief of Engineers, be authorized to construct as a Federal project for flood damage and navigation maintenance reduction, a single retention structure and associated downstream actions. The single retention structure which is described as the preferred plan, would include such modification as the Chief of Engineers deems advisable, such as provisions to raise the structures should future conditions warrant.

The first cost of the preferred plan to the United States is presently estimated at $197,200,000; average annual opertion, maintenance, and sediment monitoring costs to the United States are estimated at $925,000. Costs for maintaining the congressionally authorized 40-foot Columbia River navigation channel are excluded from costs of the preferred plan as they are regularly provided through the Corps of Engineers annual operations and maintenance budget.

Through continuous monitoring, additional information will be obtained about the rate and future magnitude of sediment deposition. If up-to-date analysis of sediment deposition and of benefits and costs of alternatives provides compelling and convincing reasons, selection of another alternative (such as a staged retention structure or dredging) may be warranted. Accordingly, concurrent analysis and design of a single retention structure, staged single retention structure, and dredging alternatives will continue. The authorization should contain sufficient flexibility to move to one of these alternatives if conditions warrant.

Authorization and subsequent implementation of a Federal project for flood damage and navigation maintenance reduction is subject to the provision that non-Federal interests shall agree to comply with the following:

a. Be responsible for conveying to the United States, prior to the time needed and without cost, all lands, easements, and rights-of-way for the single or staged retention structure and be responsible for providing without cost to the United States all lands, easements, and rights-of-way required for dredging and downstream actions, including borrow areas and dredged material disposal areas for excavated material including necessary retaining works, as determined necessary by the Chief of Engineers, for project construction and subsequent maintenance; and accomplish without cost to the United States all alterations and relocations of buildings, roads, bridges, and other structures or utilities made necessary by implementation of the project;

b. If any of the above requirements cannot be provided in a timely manner, provide a cash contribution to the United States, prior to the time needed in an amount which the Chief of Engineers determines to be necessary to allow acquisition of needed property by the United States. A final contribution adjustment to be made after actual costs are determined;

c. Operate and maintain any federally undertaken mitigation project which is determined to be justified, such as the operation and maintenance of fisheries facilities for a single retention structure;

d. Maintain all dredged material disposal sites.

In addition, I recommend that project authorization exempt the Federal Government and its contractors from the imposition of the Washington State Sales and Use Tax (Chapters 82.04, 82.08, 82.12, and 82.14 of the Revised Code of Washington), on the value of the services and materials provided under Federal contracts.

The recommendations do not reflect program and budgeting priorities inherent in the formulation of a National Civil Works construction program, nor the perspective of higher levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress for authorization and/or implementation of funding.

R.L. Friedenwald
Colonel, Corps of Engineers
District Engineer

[First endorsement]

NPDPL-PF (Dec 84)
SUBJECT: Mount St. Helens, Washington
Feasibility Report & Environmental Impact Statement

DA, North Pacific Division, Corps of Engineers
P. O. Box 2870, Portland, OR 97208-2870 18 December 1984

TO: Chief of Engineers

I concur in the conclusions and recommendations of the District Commander.

George R. Robertson

GEORGE R. ROBERTSON
Brigadier General, USA
Commanding

EXHIBIT 1

FISH AND WILDLIFE COORDINATION

This exhibit contains the U.S Fish and Wildlife Service Coordination Act Report (CAR), Corps point-by-point response to the CAR recommendations, and a biological assessment as required under Section 7(c) of the Endangered Species Act.

The following general approach was used regarding the recommendations of USFWS. We propose to provide fish passage facilities as part of the Single Retention Structure. Justification for such facilities can be provided and such facilities must be made an integral part of any single retention structure design; please refer to Appendix E regarding justification of these facilities. We propose to recommend that the operation of the fish passage facilities be provided by the State of Washington. We do not propose to acquire any lands or easements for specific fish and wildlife mitigation purposes. However, we do propose to manage lands acquired for the reservoir to provide wildlife habitat primarily by protecting and preserving wildlife habitat of these lands and to provide some limited revegetation.

RESPONSE TO COORDINATION ACT REPORT RECOMMENDATIONS

Presented in this section are the Corps of Engineers responses to the U.S. Fish and Wildlife Service recommendations contained in their final Coordination Act Report for the feasibility study addressing proposed sediment control actions for the Toutle, Cowlitz, and Columbia River Systems. We have carefully reviewed this report and their recommendations and have the following general and point-by-point responses to those recommendations.

GENERAL RESPONSE

Overall, the report does a commendable job in addressing a very complex and confusing issue - the rapidly changing fish and wildlife habitat of the project area coupled with the system-wide affects associated with the sediment reduction project being evaluated. However, the report fails to clearly identify and separate the effects on fish and wildlife caused by the eruption and those relating to the sediment control project being proposed. The chronology of fish and wildlife habitat recovery that is used for the with and without project condition greatly effects the manner and results of fish and wildlife impacts that may be anticipated. While many uncertainties do exist regarding the physical recovery of the project area, the estimate that we must base our review upon are the recovery projections presented within the feasibility study. In addition, the numerous economic values shown in your report to justify your mitigation recommendations do not fully comply with procedures delineated in Principles and Guidelines for Water and Related Land Resources Implementation. Our point-by-point responses follow.

SPECIFIC COMMENTS

General recommendations of U.S. Fish and Wildlife Service

Recommendation 1. If a SRS is considered necessary, then the Green River site be given preference for construction of a dam. The LT-3 and Kid Valley sites should be rejected because dams at these sites would produce unacceptable losses of fish and wildlife resources and habitat.

55-487 0 - 86 - 18

Response 1. We agree that the Green River site is preferrable to the LT-3 and Kid Valley site for fish and wildlife and also for engineering reasons. A single retention structure at the Green River site is the preferred plan in the feasibility report.

Recommendation 2. Fish and wildlife be made an authorized purpose of the project to ensure that action is taken to plan and implement appropriate mitigation measures.

Response 2. The primary objective of the feasibility study is to address the sedimentation problem and concomitant flood and navigation threat. We consequently do not believe including fish and wildlife as a project purpose is appropriate. However, in the recommendations presented in the feasibility report, we have included all mitigative measures for potential authorization by Congress that we believe are reasonable and appropriate.

Recommendations 3. In keeping with the requirements of the Fish and Wildlife Coordination Act, all capital and operation and maintenance costs for fish and wildlife mitigaton be treated as an "integral part of the cost of the project."

Response 3. All reasonable and necessary mitigation costs have been included in the feasibility report, including the institutional arrangements proposed for capitol costs and operation and maintenance.

Recommendation 4. All lands, water, and interests therein to achieve mitigation goals be acquired by the federal construction agency as stipulated in Section 3(c) of the Fish and Wildlife Coordination Act.

Response 4. To the extent authorized by Congress, we will carry out all fish and wildlife mitigation requirements for this project. Our findings and recommendations regarding the part of project costs, including mitigation costs, that should be borne by non-Federal interests are shown in the feasibility report in the section pertaining to cost sharing.

Recommendation 5. Necessary fish and wildlife studies and associated funding be included in any future authorization for the preferred alternative.

Response 5. Included in the recommendations for potential authorization are provisions for reasonable and necessary fish and wildlife studies.

Recommendation 6. The Corps of Engineers provide funds to fish and wildlife agencies to monitor construction impacts and the effectiveness and adequacy of mitigation programs for fish and wildlife. Approximate costs for a 25-year study which includes 5 years of continuous monitoring with periodic monitoring at 5-year intervals for 20 years thereafter amount to $840,000. A monitoring program for fish and wildlife should include studies of the following topics.

a. Water quality

b. Streamflow

c. Fish population recovery as affected by the project

d. Aquatic food chain recovery as affected by the project

e. Stream habitat recovery upstream and downstream of the project

f. Rearing pond site evaluations

g. Fish passage success

h. Wildlife studies should include monitoring of wildlife responses to project features within the study area.

Fish and Wildlife monitoring would be done concurrently and in cooperation with the Corps' 25-year project monitoring efforts.

Response 6. We believe that the evaluations and studies you have recommended are too general and all-encompassing. Many of the studies you have recommended are not directly related to this project, but rather are studies

that are more oriented toward determining impacts of the eruption and the recovery of fish and wildlife from that devastation. While we believe that certain studies relating to water quality, streamflow, and success of fish passage measures are warranted, we believe that the other studies you have recommended should more appropriately be a responsibility of the local fish and wildlife agencies as part of their normal monitoring process. We will coordinate with you the extent of studies and appropriate agency to provide those investigations relating to water quality, streamflow, and the success of fish passage facilities.

Recommendation 7. The Corps of Engineers modify mitigation measures if results of monitoring studies find such changes to be warranted.

Response 7. The primary mitigation proposed as part of the feasibility report is the construction of fish bypass facilities as part of the single retention structure. If it is determined that these facilities are inadequate, studies would be initiated to develop and, if justified, to construct new improved fish passage facilities or other mitigative measures.

Recommendation 8. Construction and non-emergency dredging activities be scheduled to protect fish and wildlife (i.e., inwater work periods, etc.). Construction techniques to protect fish and wildlife as specified by federal and state resource agencies should be incorporated in construction contracts. Contract inspection efforts should include participation by fish and wildlife biologists. This is estimated to cost $80,000 annually over the 2-year construction period. This amount is included in the monitoring program cost detailed in Recommendation 4.

Response 8. We will continue to coordinate all inwater work activities with your agency and other resource agencies in the future. To the extent reasonable and practicable, we will schedule all our activities to minimize impacts to fish and wildlife. We also plan on establishing an environmental task force to provide recommendations on minimizing adverse impacts to fish and wildlife resources during the construction period; funds appropriate to this level of involvement will be transferred to your agency.

Recommendation 9, 10, 11, 12. Existing habitats of high value to wildlife not be used as disposal sites for dredge spoils.

Areas of lower value to wildlife such as diked pasture and/or old dredge spoil disposal sites be used for dredge spoil disposal.

Herbaceous and woody vegetation be established on dredge spoil areas immediately after spoil is deposited.

Wetland creation in dredge spoil areas be investigated and implemented where feasible.

Response 9, 10, 11, 12. We will continue to coordinate all dredged material disposal with your agency and other resource agencies. We will continue to utilize disposal sites of lesser fish and wildlife value when these sites are available. As you should be fully aware, however, the magnitude and quantity of sediment that must be managed as part of this project may not allow us to limit disposal to only sites of low wildlife value. Disposal sites that have been and will be used are provided by local sponsors. The sites that have been used are seeded with herbaceous vegetation after dredged material has been deposited as part of the disposal contract. Since the Corps of Engineers does not manage these local sponsor provided disposal sites, it is not possible to comply with some of the items you have recommended. The eventual use of the disposal site would be dependent upon the land owner. However, since the State of Washington provided many of the larger disposal sites, it may be possible that many of the disposal sites could be managed for fish and wildlife enhancement. We recommend that you contact the State of Washington and provide them with your recommendations for disposal site management.

Recommendation 13. Loss of important fish and wildlife habitat due to project impacts be mitigated by development and/or improvement of other areas.

Response 13. As discussed in response to your previous recommendations, disposal sites, including the Green River Sediment Retention Structure area, may be provided by local sponsors. If any justified mitigation for the use of these sites is warranted, we believe that this should be coordinated with

these local sponsors. We do not propose, as part of our recommended plan, any land acquisition beyond that directly necessary to meet direct project needs.

Recommendation 14. The property behind the Green River structure be managed for fish and wildlife and recreational uses thereof.

Response 14. We believe that this is a reasonable use for the area behind the SRS. We will discuss this recommendation with the local sponsor who, as proposed in the cost-sharing proposal, would purchase this property.

SPECIFIC RECOMMENDATIONS

Toutle River

Recommendation 1. Successful passage be provided for anadromous fish at all barriers erected to trap sediments. Passage would be required for downstream migrating juvenile salmonids and adult fish moving upstream. Planning for and final design of such mitigation facilities must be approved by the resource agencies prior to construction of any sediment retaining structure. A trap and haul facility for adults would cost an estimated $1,000,000 in addition to annual operation and maintenance costs of $100,000. Downstream passage costs are not available.

Response 1. We propose to provide fish passage as part of the construction of the SRS. We will coordinate the planning of these facilities with the appropriate resource agencies.

Recommendation 2. When feasible, a single defined stream channel be maintained in summer through impounded sediments to improve adult and juvenile fish passage.

Response 2. We will investigate the feasibility of this recommendation.

Recommendation 3. A stream channel designed to permit fish passage and prevent stranding of adult and juvenile salmonids be maintained through all work areas (including the LT-1 and LT-3 dredging sites).

Response 3. As in prior construction contracts for operation of the sediment retention structures, we will specify that a stream channel be maintained through these work areas to permit fish passage and to prevent stranding of adult and juvenile salmonids.

Recommendation 4. Rearing ponds be constructed to mitigate losses of Alder Creek and Deer Springs fish facilities inundated by sediment.

Response 4. If these facilities are inundated by sediment as a result of construction of the SRS, they would be replaced consistent with all other project related relocations.

Recommendation 5. Riparian and instream habitat be improved at project cost at sites downstream of the Green River Dam to mitigate for project-related losses of instream and riparian habitat. Possible sites for riparian plantings include Disappointment, Trouble, Goat, and Dollar Creeks at a cost of about $82,000. These restoration measures should be implemented concurrently with the 2-year dam construction period. Suitable instream habitat improvement sites include, but are not limited to, the mainstem Green and South Fork Toutle Rivers, Devils and Thirteen Creeks, and at an unnamed South Fork tributary (Section Lines 22 and 23, T9N, R2E). Costs for the mainstem work would range from $60,000 to $212,000 and for the passage improvements about $100,000. The final selection of suitable mitigation measures and sites should be accomplished through a coordinated planning effort involving the Corps, affected landowners, public land management agencies, and fish and wildlife agencies.

Response 5. Some of the actions recommended appear to have merit from a fish and wildlife perspective and also in providing some additional sediment control benefits. Since incremental justification for these actions have yet to be determined, we propose to investigate these recommendations in greater detail in the Continued Planning and Engineering Stage to determine benefits, costs, and institutional arrangements for potential implementation. Since the Department of Interior has existing authorities to provide passage at obstructions to anadromous fish migration, we recommend that the passage improvements you have delineated be provided by your agency.

Recommendation 6. Wildlife habitat within the sediment storage area upstream of the SRS be maintained as long as possible. Lands outside the sediment inundation zone, but within Corps ownership, should also be maintained for wildlife. Timber harvest should cease on this land to minimize the impact of wildlife lost gradually over the 50-year project life.

Response 6. This is a very reasonable recommendation for minimizing loss of wildlife habitat. However, before we can reply to this recommendation, we will have to analyze the impact of additional debris to the structure and the spillway. We will advise you of our findings. One point of clarification, however, these lands may not be owned by the Corps but by the local sponsor.

Recommendation 7. The LT-1 and LT-3 disposal sites be finished in irregular contours, seeded, planted to woody vegetation, and fertilized to aid in erosion control and development of wildlife habitat. Costs associated with vegetative plantings are about $98,300.

Response 7. The dredged material disposal sites that you have referenced are owned by local sponsors. If agreed to by these sponsors, we will finish these sites in irregular contours. We propose to seed and fertilize these sites at the conclusion of disposal activities. The planting of woody vegetation would be a responsibility of the land owner. For the LT-1 site, the landowners are the State of Washington and Cowlitz County. We propose that our respective agencies meet with these landowners.

Recommendation 8. Periodic seeding and fertilization of the sediment inundation area with Dutch white clover, orchard grass, and red clover mix continue throughout the life of the project.

Response 8. The area at the edge of the pool is a very volitile reach, where inundation could occur at any time. Consequently, we do not believe that spending funds to provide very temporary wildlife habitat in this area is justifiable. Once the sedimentation and infilling of the reservoir subsides, then, it is reasonable for someone to provide the seeding you recommend.

Recommendation 9. Elk forage such as ninebark, huckleberry, salal, and Oregon

grape be planted on Corps lands outside the sediment inundation zone to replace forage lost to sediment coverage.

Response 9. These lands, as proposed in the cost-sharing proposal, may be owned by local sponsors. We will discuss this recommendation with the sponsor to develop the institutional arrangements for providing needed wildlife habitat.

Recommendation 10. Existing herbaceous vegetation be maintained at the base of the debris avalanche. Any part of the seeded debris avalanche which is under Corps ownership should be maintained to benefit deer and elk.

Response 10. See response #9.

Recommendation 11. Temporary protection of existing riparian vegetation along the Green River, North Fork Toutle River, and upper Hoffstadt Creek drainages be established to offset wildlife habitat losses within the sediment inundation zone. The major action needed would be cessation of timber harvest in the riparian zone. This protection would begin at the time of project construction and would be dropped as mitigation is implemented. Specific actions should be developed through a cooperative planning effort involving the affected landowners and fish and wildlife agencies.

Response 11. Initiating the specific forest practices you have proposed is a State responsibility. The State of Washington currently has a Forest Practices Act.

COWLITZ RIVER

Recommendations 1 and 2. Disposal areas be finished in irregular contours to increase habitat diversity.

Eroding streambanks and dredge spoil disposal areas be fertilized and revegetated immediately with herbaceous and woody plants.

Responses 1 and 2. Please refer to Toutle River response #7.

Recommendation 3. Public access be provided to State owned or managed disposal areas.

Response 3. Public access to State owned area is a responsibility of the State.

COLUMBIA RIVER

Recommendation 1. As much bedload material as possible be kept out of the Columbia River System, and especially the estuary by:

a. Operation of the Cowlitz River Sump;

b. Establishment of sumps in the Columbia where there are adequate upland disposal sites.

Response 1. We concur with your recommendation.

Recommendation 2. In-water disposal sites for dredge spoils be located where material would not be deposited in shallow water areas or entrances to sloughs and backwaters.

Response 2. To the extent practicable, we will comply with this request.

Recommendation 3. Dredged materials be disposed of in the following sites in order of priority; 3, 1, 5, 11, 10, 3, 18, 15, 9, and 13 (Figures 16 and 17).

Response 3. To the extent practicable, these sites will be given priority for dredged material disposal.

Recommendation 4. Mitigation for habitat values lost be required before use of sites 2, 9, 13, 15, 18, 19, 23, and 24. Assuming that some of these sites are used for dredge spoil disposal, the estimated mitigation cost for this measure would range from $250,000 to $1.5 million.

Response 4. While Columbia River dredging is discussed in the feasibility report to provide a comprehensive evaluation of impacts, no specific

authorization or funding is requested for actions necessary to maintain this navigable waterway. Authority is already provided under P.L. 87-874 for actions pertaining to federal maintenance of the Columbia River navigation channel. As part of this authorization, local sponsors are to provide the lands necessary for dredged material disposal. We are willing to discuss the use of these local sponsor provided disposal lands under the coordination procedures established for this maintenance dredging. Construction of the SRS, as proposed, would substantially reduce the Columbia River dredging requirement.

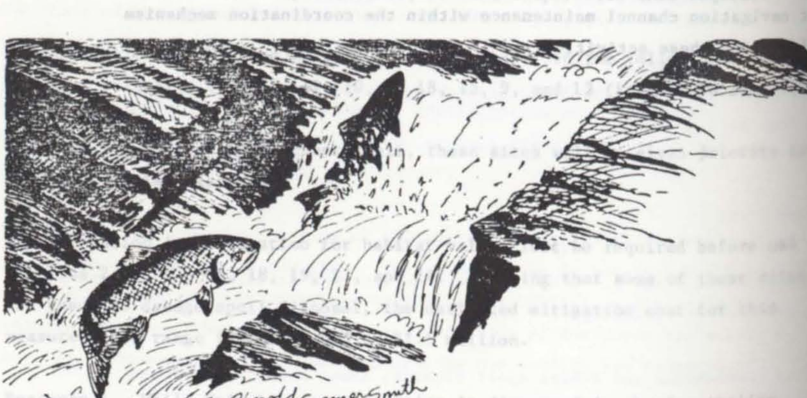
Recommendation 5. A plan be developed under the authority of the Fish and Wildlife Coordination Act which identifies specific actions needed to mitigate for impacts of dredging and dredged material disposal. This plan should be guided by a task group of interested agencies, and should be developed to address both short- and long-term dredging needs and concerns. The plan would cost an estimated $50,000 and should be developed concurrently with detailed planning for project facilities (approximately 12 months). As the construction agency, the Corps would be responsible for implementation of mitigation measures identified through this planning process. These measures should be implemented concurrently with project dredging activities.

Response 5. We are willing to participate in discussions relating to Columbia River navigation channel maintenance within the coordination mechanism developed for these activities.

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

THE IMPACTS ON FISH AND WILDLIFE OF PROPOSED SEDIMENT CONTROL ACTIONS FOR THE TOUTLE, COWLITZ, AND COLUMBIA RIVER SYSTEMS



REGION ONE

DECEMBER 1984

FISH AND WILDLIFE COORDINATION ACT REPORT

THE IMPACTS ON FISH AND WILDLIFE OF PROPOSED ACTIONS FOR CONTROLLING FLOODING AND NAVIGATION PROBLEMS CAUSED BY THE ERUPTION OF MOUNT ST. HELENS

by

Nancy J. Ellifrit, Kathleen A. Larson, and Elaine J. Rybak

December 1984

Prepared for the Portland District
U. S. Army Corps of Engineers
by the
Portland and Olympia Ecological Services Field Offices
U. S. Fish and Wildlife Service

PREFACE

This is the Fish and Wildlife Service's detailed report on the Corps of Engineers' Mount St. Helens, Washington Feasibility Study.

Our analysis of project impacts on fish and wildlife is based on: 1) project information and engineering data received prior to November 30, 1984; 2) an appraisal of existing and projected resources; and 3) a project life of 50 years. Previous reports submitted on this project are planning aid letters in March and April 1983 and May 1984, and a reconnaissance report of September 1983.

This report does not constitute the review comments of the Department of the Interior on the draft environmental impact statement as required under provisions of the National Environmental Policy Act (Public Law 91-190). It should also be noted that the proposed project may be subject to permits over which the Fish and Wildlife Service has review responsibilities. Accordingly, our comments do not preclude an additional and separate evaluation by the Service, pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. 661, et seq.), if eventual project development requires a permit from the Corps of Engineers, U.S. Army (Section 10 of the River and Harbor Act of 1899). All such permits are subject to separate review by the Service under existing statutes, executive order, memorandum of agreement, and other authorities. In review of permit applications, the Fish and Wildlife Service may concur, with or without stipulations, or object to the proposed work, depending on specific construction practices which may impact fish and wildlife resources.

The recreational and commercial values assigned to salmon and steelhead are derived from the following report, "Net Economic Values for Salmon and Steelhead from the Columbia River System" developed for the National Marine Fisheries Service by Meyer-Zangri Associates, Inc. All values derived from this report reflect 1980 dollars and no attempt has been made to incorporate inflationary updates. Values for searun cutthroat, resident trout, and wildlife were derived from data provided by the Washington Department of Game.

The U. S. Fish and Wildlife Service mitigation policy (Federal Register, 1981) was used in preparing this report. This policy assures consistent and effective recommendations for project mitigation and outlines various methods for achieving such mitigation. The policy covers impacts to fish and wildlife populations, their habitat, and the human uses thereof.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

December 13, 1984

Colonel Robert L. Friedenwald, District Engineer
Portland District, Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald:

This expresses the Fish and Wildlife Service's position on the effects of a proposed project to control sedimentation and flooding in the Toutle, Cowlitz, and Columbia Rivers. The proposed work would be implemented because of existing and potential problems associated with the 1980 eruption of Mount St. Helens. This statement and the attached detailed report constitute our Fish and Wildlife Coordination Act Report in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and is consistent with the intent of the National Environmental Policy Act. Our report is intended for inclusion in your Feasibility Report which was authorized by recommendation of the Assistant Secretary of the Army. This recommendation was contained in a Corps of Engineers (Corps) report to the President on a comprehensive plan for responding to the long-term threat created by the 1980 eruption of Mount St. Helens.

This report has been coordinated with and has the concurrence of the Washington Departments of Fisheries and Game and Oregon Department of Fish and Wildlife as indicated in their attached letters of December 3, December 4, and November 30, 1984, respectively. It was also developed in cooperation with the National Marine Fisheries Service.

Project features being evaluated include three Single Retention Structure (SRS) alternatives on the North Fork Toutle River. The SRS concept consists of construction of a dam to create a slack-water pool in which a major portion of water-borne sediments would settle or drop out. This would prevent large quantities of materials from entering the lower Cowlitz and Columbia Rivers, minimizing future dredging

requirements and the problems associated therewith. A total of 14 different spillway height and outlet structure combinations are included in the SRS analysis.

The Supplemental Appropriations Act of 1983 (PL 98-63) authorized the Corps to implement and maintain flood control measures to assure 100-year flood protection for developed areas on the Cowlitz and Toutle Rivers and to reduce sediment flow into the Columbia River. Under PL 98-63, the levees along the Cowlitz have been raised and dredging has occurred on the Cowlitz between RM 13.5 and 20 and at the sediment stabilization basin, LT-1, on the Toutle River. These actions are considered the base condition for the proposed project.

Sumps dredged near the mouth of the Cowlitz River are also included in the proposed project. Materials settling in the sumps would be removed and placed in water and on wetland and upland sites.

The Service's analysis indicates that project construction and operation could cause serious impacts on fish and wildlife resources. Large runs of anadromous fish could be blocked from spawning areas, valuable fish and wildlife habitat could be permanently lost in the SRS pool(s), and wildlife habitat could be covered with material dredged from channels and sumps. The no action alternative could also cause serious impacts to fish and wildlife as large quantities of Mount St. Helens materials would settle in the Cowlitz and Columbia Rivers (including the Columbia River Estuary). These materials would smother inwater habitats and require extensive maintenance dredging which would in turn cause loss of wildlife habitat at disposal sites. A given assumption for all project analyses is that maintenance dredging would continue on the Columbia River to maintain the 40-foot navigation channel.

The basic premise behind the Service's analysis of impacts is that the rapid, natural recovery of important fish and wildlife habitats that has been observed since the blast, would continue in the future without a project. It is assumed that eventually the area would return to its preblast conditions for fish and wildlife resources. These resources were of significant value to the local area, both socially and economically, and are assumed to be so in the future. Thus, while project features might be built or operated in areas where the habitats are presently degraded, to the extent they would prevent the natural and otherwise uninterrupted recovery of the area, they would have potential impacts to fish and wildlife resources.

Previous drafts of this report contained recommendations which, because of the number of potential alternatives and the lack of specific project information, were necessarily general. Those recommendations represented a full range of potential mitigation actions for all of the alternatives. However, with selection of a preferred plan at the Green River site, fewer and less extensive mitigation actions would be required. While all the alternatives are still discussed within the report, the recommendations have been developed specifically to mitigate for losses associated with the selected plan and its specific impacts.

With input from other federal and state resource agencies, the Service has developed the following recommendations to mitigate for project impacts to fish and wildlife resources. It should be noted that the recommended actions address project impacts only. They are not designed to mitigate for impacts of the eruption of Mount St. Helens. It should also be noted that the recommended actions are designed to be accomplished concurrently with detailed planning and construction of project features. Ultimately, their purpose is to assist in developing an environmentally sound project compatible with applicable environmental policies and legislation, without delaying necessary efforts to solve flooding and sedimentation problems associated with the eruption of Mount St. Helens.

RECOMMENDATIONS

It is recommended that:

1. If a SRS is considered necessary, then the Green River site be given preference for construction of a dam. The LT-3 and Kid Valley sites should be rejected because dams at these sites would produce unacceptable losses of fish and wildlife resources and habitat.

2. Fish and wildlife be made an authorized purpose of the project to ensure that action is taken to plan and implement appropriate mitigation measures.

3. In keeping with the requirements of the Fish and Wildlife Coordination Act, all capital and operation and maintenance costs for fish and wildlife mitigation be treated as an "integral part of the cost of the project."

4. All lands, water, and interests therein to achieve mitigation goals be acquired by the federal construction agency as stipulated in Section 3(c) of the Fish and Wildlife Coordination Act.

5. Necessary fish and wildlife studies and associated funding be included in any future authorization for the preferred alternative.

6. The Corps of Engineers provide funds to fish and wildlife agencies to monitor construction impacts and the effectiveness and adequacy of mitigation programs for fish and wildlife. Approximate costs for a 25-year study which includes 5 years of continuous monitoring with periodic monitoring at 5-year intervals for 20 years thereafter amount to $840,000. A monitoring program for fish and wildlife should include studies of the following topics.

   a. Water quality

   b. Streamflow

   c. Fish population recovery as affected by the project

   d. Aquatic food chain recovery as affected by the project

   e. Stream habitat recovery upstream and downstream of the project

   f. Rearing pond site evaluations

   g. Fish passage success

   h. Wildlife studies should include monitoring of wildlife responses to project features within the study area.

   Fish and Wildlife monitoring would be done concurrently and in cooperation with the Corps' 25-year project monitoring efforts.

7. The Corps of Engineers modify mitigation measures if results of monitoring studies find such changes to be warranted.

8. Construction and non-emergency dredging activities be scheduled to protect fish and wildlife (i.e., inwater work periods, etc.). Construction techniques to protect fish and wildlife as specified by federal and state resource agencies should be incorporated in construction contracts. Contract inspection efforts should include participation by fish and wildlife biologists. This is estimated to cost $80,000 annually over the 2-year construction period. This amount is included in the monitoring program cost detailed in Recommendation 4.

9. Existing habitats of high value to wildlife not be used as disposal sites for dredge spoils.

10. Areas of lower value to wildlife such as diked pasture and/or old dredge spoil disposal sites be used for dredge spoil disposal.

11 Herbaceous and woody vegetation be established on dredge spoil areas immediately after spoil is deposited.

12. Wetland creation in dredge spoil areas be investigated and implemented where feasible.

13. Loss of important fish and wildlife habitat due to project impacts be mitigated by development and/or improvement of other areas.

14. The property behind the Green River structure be managed for fish and wildlife and recreational uses thereof.

SPECIFIC RECOMMENDATIONS

Toutle River

It is recommended that:

1. Successful passage be provided for anadromous fish at all barriers erected to trap sediments. Passage would be required for downstream migrating juvenile salmonids and adult fish moving upstream. Planning for and final design of such mitigation facilities must be approved by the resource agencies prior to construction of any sediment retaining structure. A trap and haul facility for adults would cost an estimated $1,000,000 in addition to annual operation and maintenance costs of $100,000. Downstream passage costs are not available.

2. When feasible, a single defined stream channel be maintained in summer through impounded sediments to improve adult and juvenile fish passage.

3. A stream channel designed to permit fish passage and prevent stranding of adult and juvenile salmonids be maintained through all work areas (including the LT-1 and LT-3 dredging sites).

4. Rearing ponds be constructed to mitigate losses of Alder Creek and Deer Springs fish facilities inundated by sediment.

5. Riparian and instream habitat be improved at project cost at sites downstream of the Green River Dam to mitigate for project-related losses of instream and riparian habitat. Possible sites for riparian plantings include Disappointment, Trouble, Goat, and Dollar Creeks at a cost of about $82,000. These restoration measures should be implemented concurrently with the 2-year dam construction period. Suitable instream habitat improvement sites include, but are not limited to, the mainstem Green and South Fork Toutle Rivers, Devils and Thirteen Creeks, and at an unnamed South Fork tributary (Section Lines 22 and 23, T9N, R2E). Costs for the mainstem work would range from $60,000 to $212,000 and for the passage improvements about $100,000. The final selection of suitable mitigation measures and sites should be accomplished through a coordinated planning effort involving the Corps, affected landowners, public land management agencies, and fish and wildlife agencies.

6. Wildlife habitat within the sediment storage area upstream of the SRS be maintained as long as possible. Lands outside the sediment inundation zone, but within Corps ownership, should also be maintained for wildlife. Timber harvest should cease on this land to minimize the impact of wildlife lost gradually over the 50-year project life.

7. The LT-1 and LT-3 disposal sites be finished in irregular contours, seeded, planted to woody vegetation, and fertilized to aid in erosion control and development of wildlife habitat. Costs associated with vegetative plantings are about $98,300.

8. Periodic seeding and fertilization of the sediment inundation area with Dutch white clover, orchard grass, and red clover mix continue throughout the life of the project.

9. Elk forage such as ninebark, huckleberry, salal, and Oregon grape be planted on Corps lands outside the sediment inundation zone to replace forage lost to sediment coverage.

10. Existing herbaceous vegetation be maintained at the base of the debris avalanche. Any part of the seeded debris avalanche which is under Corps ownership should be maintained to benefit deer and elk.

11. Temporary protection of existing riparian vegetation along the Green River, North Fork Toutle River, and upper Hoffstadt Creek drainages be established to offset wildlife habitat losses within the sediment inundation zone. The major action needed would be cessation of timber harvest in the riparian zone. This protection would begin at the time of project construction and would be dropped as mitigation is implemented. Specific actions should be developed through a cooperative planning effort involving the affected landowners and fish and wildlife agencies.

Cowlitz River

It is recommended that:

1. Disposal areas be finished in irregular contours to increase habitat diversity.

2. Eroding streambanks and dredge spoil disposal areas be fertilized and revegetated immediately with herbaceous and woody plants.

3. Public access be provided to State owned or managed disposal areas.

Columbia River

It is recommended that:

1. As much bedload material as possible be kept out of the Columbia River System, and especially the estuary by:

   a. Operation of the Cowlitz River Sump;

   b. Establishment of sumps in the Columbia where there are adequate upland disposal sites.

2. In-water disposal sites for dredge spoils be located where material would not be deposited in shallow water areas or entrances to sloughs and backwaters.

3. Dredged materials be disposed of in the following sites in order of priority; 3, 1, 5, 11, 10, 2, 18, 15, 9, and 13 (Figures 16 and 17).

4. Mitigation for habitat values lost be required before use of sites 2, 9, 13, 15, 18, 19, 23, and 24. Assuming that

some of these sites are used for dredge spoil disposal, the estimated mitigation cost for this measure would range from $250,000 to $1.5 million.

5. A plan be developed under the authority of the Fish and Wildlife Coordination Act which identifies specific actions needed to mitigate for impacts of dredging and dredge material disposal. This plan should be guided by a task group of interested agencies, and should be developed to address both short- and long-term dredging needs and concerns. The plan would cost an estimated $50,000 and should be developed concurrently with detailed planning for project facilities (approximately 12 months). As the construction agency, the Corps would be responsible for implementation of mitigation measures identified through this planning process. These measures should be implemented concurrently with project dredging activities.

Please advise us of your proposed actions regarding the above recommendations. We look forward to continued coordination with you as project planning continues.

Sincerely yours,

Richard J. Myshak

Richard J. Myshak
Regional Director

JOHN SPELLMAN
Governor

WILLIAM R. WILKERSON
Director

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

December 3, 1984

Richard J. Myshak
Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 Northeast Multnomah
Portland, Oregon 97232

Dear Mr. Myshak:

Coordination Act Report - Final Draft, The Impacts on Fish and Wildlife of Proposed Sediment Control Action for the Toutle, Cowlitz and Columbia River Systems

We have reviewed your final draft Coordination Act Report (CAR) and generally agree with its contents. Your assessment of the effects of the proposed projects is adequate given the Corps of Engineers' uncertain estimates of the manner in which the sediment will be delivered from the North Fork Toutle River and the ambiguity which exists as to how the projects will affect the "recovery" of the watershed.

This most clearly demonstrates the need for general recommendations 2 - 5 which request complete monitoring of the effects of these projects during construction and after to more specifically identify mitigation measures necessary for the protection of fish and wildlife.

We concur with the remaining general recommendations as well as the specific recommendations except for Toutle River Number 6 and Cowlitz River Number 1. We do not feel the measures are necessary or feasible to implement.

Thank you for the opportunity to provide input into the earlier drafts of this CAR and to provide you with this letter of concurrence on the final report.

Sincerely,

Duane Phinney for

William R. Wilkerson
Director

cc: Keller
Mohoric
Zillges

JOHN SPELLMAN
Governor

FRANK LOCKARD
Director

STATE OF WASHINGTON

DEPARTMENT OF GAME
5405 N.E. Hazel Dell Avenue
Vancouver, Washington 98663
December 4, 1984

Richard L. Myshak, Regional Director
U. S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 N. E. Multnomah Street
Portland, Oregon, 97232

RE: Final Draft -- Fish and Wildlife Coordination Act Report, Corps of Engineers Mount St. Helens Feasibility Report

Dear Mr. Myshak:

Washington Game Department staff have reviewed the final Draft of the Coordination Act Report on the Corps of Engineers Mount St. Helens Feasibility Report.

We recognize and acknowledge the fine line between Mount St. Helens eruption related fish and wildlife impacts and Corps of Engineers action related fish and wildlife impacts. We commend you for recognizing and separating the issues to address only fish and wildlife mitigation for Corps of Engineers actions.

You state many times in the Coordination Act Report the Corps of Engineers is responsible for fish and wildlife mitigation. We object to the Corps of Engineers proposal that the State of Washington fund the O & M for fish passge or mitigation. The Corps of Engineers is responsible for fish and wildlife mitigation programs for Corps of Engineers owned and operated dams. Two examples are the Wynochee Dam on the Wynochee River and Mudd Mountain Dam on the White River in Washington State.

We concur with the findings and recommendations of the Coordination Act Report and emphasize the Corps of Engineers fund and initiate fish and wildlife mitigation planning, feasibility studies, and design schedules to coincide with other project planning phases.

Sincerely,

WASHINGTON DEPARTMENT OF GAME

Claude Stoddard

Claude Stoddard
Regional Habitat Manager

CS:pl

cc: Groen
O'Neil
Crawford
Zarnowitz
Drivdahl
Keller, WDG
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Dugger

VICTOR ATIYEH
GOVERNOR

Department of Fish and Wildlife

506 S.W. MILL STREET, P.O. BOX 3503, PORTLAND, OREGON 97208

November 30, 1984

Mr. Richard J. Myshak
Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building
Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

Dear Mr. Myshak:

The Oregon Department of Fish and Wildlife concurs with the draft Fish and Wildlife Coordination Act Report - The Impacts on Fish and Wildlife of Proposed Sediment Control Actions for the Toutle, Cowlitz, and Columbia River Systems.

Thank you for the opportunity to review this report.

Sincerely,

Franklin R. Young for

Michael C. Weland
Chief
Environmental Management Section

MCW:kes

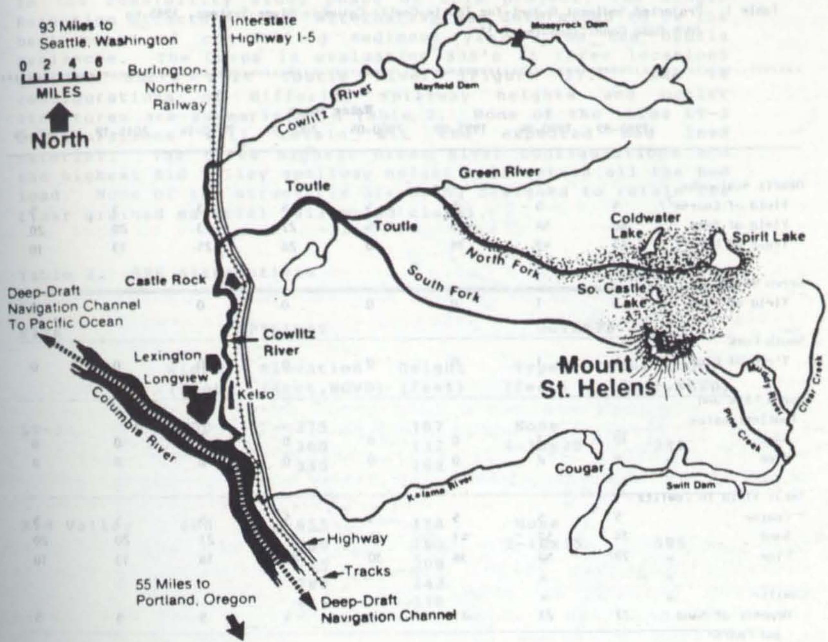
DESCRIPTION OF THE PROJECT

The eruption of Mount St. Helens in 1980 displaced an estimated 4 billion cubic yards of material from the top and center of the mountain. The resulting mud and pyroclastic flows deposited over 1 billion cubic yards of material in the Toutle, Cowlitz, and Columbia Rivers. The Cowlitz and Toutle Valleys were flooded and considerable infill occurred in the Cowlitz River. Approximately 50 million cubic yards (mcy) of material was deposited in the Columbia River, blocking the navigation channel (Figure 1). Concentrated efforts by the Corps of Engineers in the ensuing 18 months removed the blockage to the navigation channel and restored a measure of flood protection capacity to the Cowlitz River.

Approximately 3.3 billion cubic yards of material in the debris avalanche remains in the upper 14 miles of the North Fork Toutle River. It is estimated that about 650 mcy will erode and be transported by the river system. Debris avalanche yields to the North Fork Toutle River are projected to be approximately 28 mcy annually at present, dropping to 16 mcy by the year 2000 and to 7 mcy per year after 2018. Of this material 380 mcy is sand size or larger and much will be deposited in the Cowlitz and Columbia River Systems. An estimated 50 mcy of gravel and larger material will erode out of the debris avalanche and be deposited in the Toutle River and the upper Cowlitz River. The finer material (30 percent of total) will be carried in suspension into the Columbia River and much will be carried out into the Pacific Ocean. Some of the finer material will be deposited in the Columbia River estuary.

A small amount of sand size material and much of the gravel will remain in the Toutle River. Extensive channel changes in the Toutle will continue for a number of years. Approximately 74 mcy of sand size material will also be deposited in the Cowlitz, but 521 mcy will be passed through to the Columbia. The Cowlitz will reach stability in the form of a braided stream in about 50 years. Table 1 shows this process for a 40-year period.

The Corps of Engineers was requested by local, state, and federal officials to determine a long-term solution to the flooding and navigation problems posed by this material. A Comprehensive Plan for Responding to the Long-Term Threat Created by the Eruption of Mount St. Helens, Washington, was forwarded to the President of the United States on November 3, 1983. Six alternatives were considered in this plan.



The shaded portion denotes the debris avalanche.

Figure 1. Project area.

Table 1. Projected Sediment Budget for Toutle-Cowlitz-Columbia River Systems, 1985 to 2024 Base Conditions (mcy)[1]

	Water Years							
	1985-89	1990-94	1995-99	2000-04	2005-09	2010-14	2015-19	2020-24
Debris Avalanche								
Yield of Coarse[2]	5	5	5	5	5	5	5	5
Yield of Sand	66	54	43	35	27	23	20	20
Yield of Fine[3]	61	49	38	30	26	25	13	10
Green River								
Yield of Fine	5	1	0	0	0	0	0	0
South Fork								
Yield of Fine	5	1	0	0	0	0	0	0
North Fork and Toutle Erosion								
Sand	10	3	0	0	0	0	0	0
Fine	8	2	0	0	0	0	0	0
Total Yield to Cowlitz								
Coarse	5	5	5	5	5	5	5	5
Sand	76	57	43	35	27	23	20	20
Fine	79	53	38	30	26	18	13	10
Cowlitz								
Deposit of Sand and Coarse	27	21	13	6	5	5	5	5
Erosion of Sand and Coarse	0	0	0	1	5	7	10	10
Total Yield to Columbia								
Sand	54	41	35	35	32	30	30	30
Fine	79	53	37	30	26	18	13	10

1/ From Corps of Engineers.
2/ Coarse = larger than 2mm.
3/ Fine = smaller than 0.0625 mm.

In the Feasibility Study phase of this project, the Single Retention Structure (SRS) Alternative was determined to be the best means of controlling sediment yield from the debris avalanche. The Corps is evaluating SRS's at three locations on the North Fork Toutle River (Figure 2). The 14 configurations of differing spillway heights and outlet structures are summarized in Table 2. None of the three LT-3 configurations will retain all the expected bed load material. The three highest Green River configurations and the highest Kid Valley spillway height will retain all the bed load. None of the structures are being designed to retain the finer grained material (silts and clays).

Table 2. SRS Alternatives

SITE	SPILLWAY			OUTLETS	
	Width (feet)	Elevation (feet,NGVD)	Height (feet)	Type (feet)	Elevation (feet,NGVD)
LT-3	500	275	107	None	
		300	132	4-10x20	240
		330	162	"	"
Kid Valley	600	655	118	None	
		700	163	2-10x15	595
		745	208	"	"
		780	243	"	"
		855	318	"	"
Green River	600	865	77	None	
		900	112	2-5x9	820
		930	142	"	"
		965	177	"	"
		990	202	"	"
		1,060	272	"	"

The Supplemental Appropriations Act of 1983 (PL 98-63) authorized the Corps to implement and maintain flood control measures to assure 100-year flood protection for developed areas on the Cowlitz and Toutle Rivers and to reduce sediment

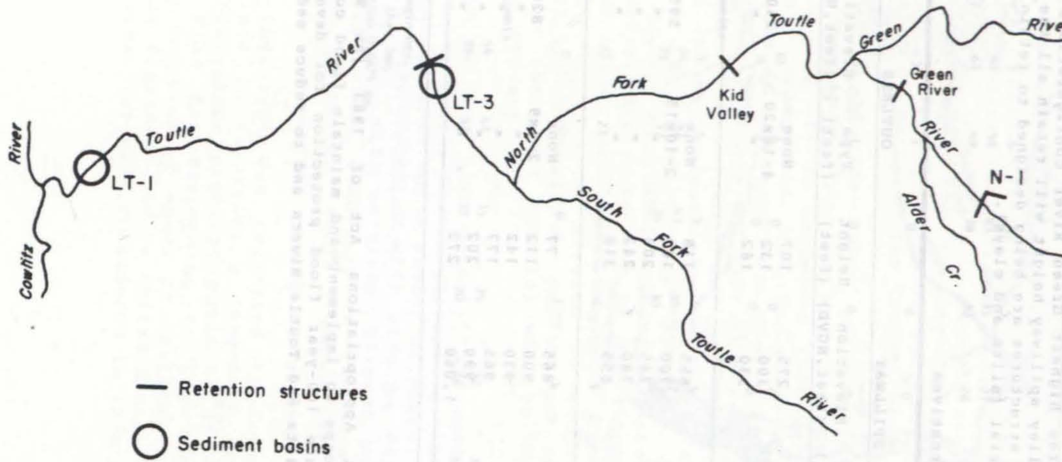


Figure 2. Sites of proposed basins and structures on the Toutle River.

flow into the Columbia River. Actions taken to date under PL 98-63 include raising of levees along the Cowlitz, dredging the Cowlitz between RM 13.5 and 20, and dredging at LT-1 on the Toutle. These actions are considered to be the base condition. Dredging will probably be used to maintain the 100-year flood protection until a SRS is operational.

A sump at the mouth of the Cowlitz has been dredged the past 3 years to prevent material from entering the Columbia River and the navigation channel. This action is expected to continue for as long as it is considered effective.

The preferred plan, which is also the National Economic Development (NED) plan, is the single retention structure at the Green River site. Also included are downstream dredging and some levee reinforcement.

The Green River Dam would have a 177-foot-high spillway. The impoundment area created would have a maximum sediment storage capacity of 411 mcy and a 50-year trapping capability of 299 mcy. This structure could store all the sediment from a 100-year frequency flood event until the year 1995 and a large mudflow event until 1991.

Details of the dam structure have not been finalized, but generally the structure would be a roller compacted concrete (R.C.C.) gravity dam. It would have an ungated overflow spillway 600 feet wide discharging into a stilling basin and two regulating outlets. The intakes would be part of the dam. Once the sediment reaches the level of the trash rack, stoplogs would be used incrementally to close the intakes. Figure 3 shows a schematic of the dam.

Bank protection would be provided as needed to control erosion either downstream or in the reservoir. Streambed protection would be provided for 100 feet downstream from the stilling basin and bank protection for approximately 600 feet downstream.

The Green River SRS is designed to operate with a minimum normal pool level, which would allow fines to pass through the structure. Summer water levels would be low. At times the pool would resemble a dry lake with a river flowing through it. Once the pool is filled with sediment, there would be no peak flood control and flood waters would pass directly over the spillway.

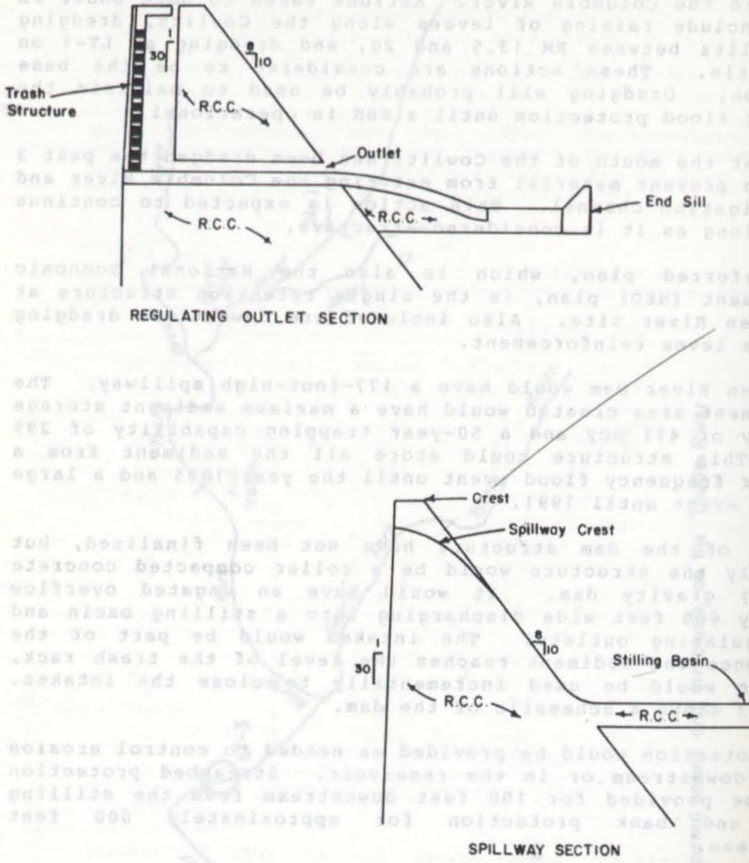


Figure 3. Schematic of SRS,

An adult fish collection facility would be constructed, consisting of a water supply, holding pond, and fish trap. Provisions would also be made to pass downstream migrants through the regulating outlets.

Initially a cofferdam would be built upstream of the damsite to divert the North Fork Toutle and to act as an interim sediment structure. Dredging would continue in downstream areas until the structure is in place and most of the material already in the system below the Green River site has eroded. It is planned that 29 mcy of material would be dredged from LT-1 and LT-3 over the next 2 years. The Cowlitz sump would operate for approximately 5 years, removing 15 mcy.

It is expected that there will be localized reinforcement and repair of existing levees and riprapping to prevent excessive bank erosion.

The no-action alternative presumes that no structure will be built and that action will not be taken under PL 98-63, although the Columbia River Navigation Channel would be maintained.

Our report, while discussing other alternatives, will concentrate on evaluating the effects of the provisions of P.L. 98-63, Cowlitz sump dredging, the no action alternative, and the Green River retention structure at 177-foot spillway height.

TOUTLE RIVER

The Toutle River Basin is typical of drainage basins on the west slopes of the Cascade Range with mountainous and heavily forested terrain. The headwaters of the Toutle River arise in steep, high elevation land with shallow to deep, well-drained soils formed of volcanic ash, glacial materials, and weathered parent rock. The mid-section of the watershed is characterized by moderate to very steep slopes on foothills. Soils in this area are deep loamy and clayey types formed from weathered parent rocks, and volcanic ash and pumice. The lower one-third of the watershed to the mouth is nearly level with strong slopes on terraces, foothills, and valleys. These are also loamy and clayey soils, but formed in alluvium (USDA 1974).

The Toutle River is a large tributary of the Cowlitz River which in turn is a major tributary of the Columbia River. The Toutle River is formed by three major tributaries. These are: the North Fork, which originates at Spirit Lake and drains the northern slopes of Mount St. Helens; the South Fork, which drains the western flank of the mountain; and the Green River, which drains forested areas north of the mountain. Before the eruption average flow in the Toutle River near its mouth was about 2,100 cubic feet per second (cfs). Maximum and minimum flows recorded were 43,200 cfs and 240 cfs respectively.

Water quality for fish life was generally good to excellent. Maximum water temperature recorded in 1979 was 68°F (USGS, 1980). The water was clear during most of the year. Higher turbidities occurred during winter freshets and in summer when hot weather melted glaciers on Mount St. Helens.

FISH

Pre-eruption

The Toutle River System provided excellent habitat for anadromous fish. Figure 4 shows the pre-eruption distribution of these fish. Anadromous fish included spring and fall chinook and coho salmon; winter and summer steelhead; and searun cutthroat trout. All species spawned naturally within the river system and used all accessible waters for spawning or rearing. Natural runs were augmented by hatchery produced fish which were stocked at several locations in the System. These migratory fish contributed to important commercial and sport fisheries in the Toutle River System, Cowlitz and Columbia Rivers, and Pacific Ocean.

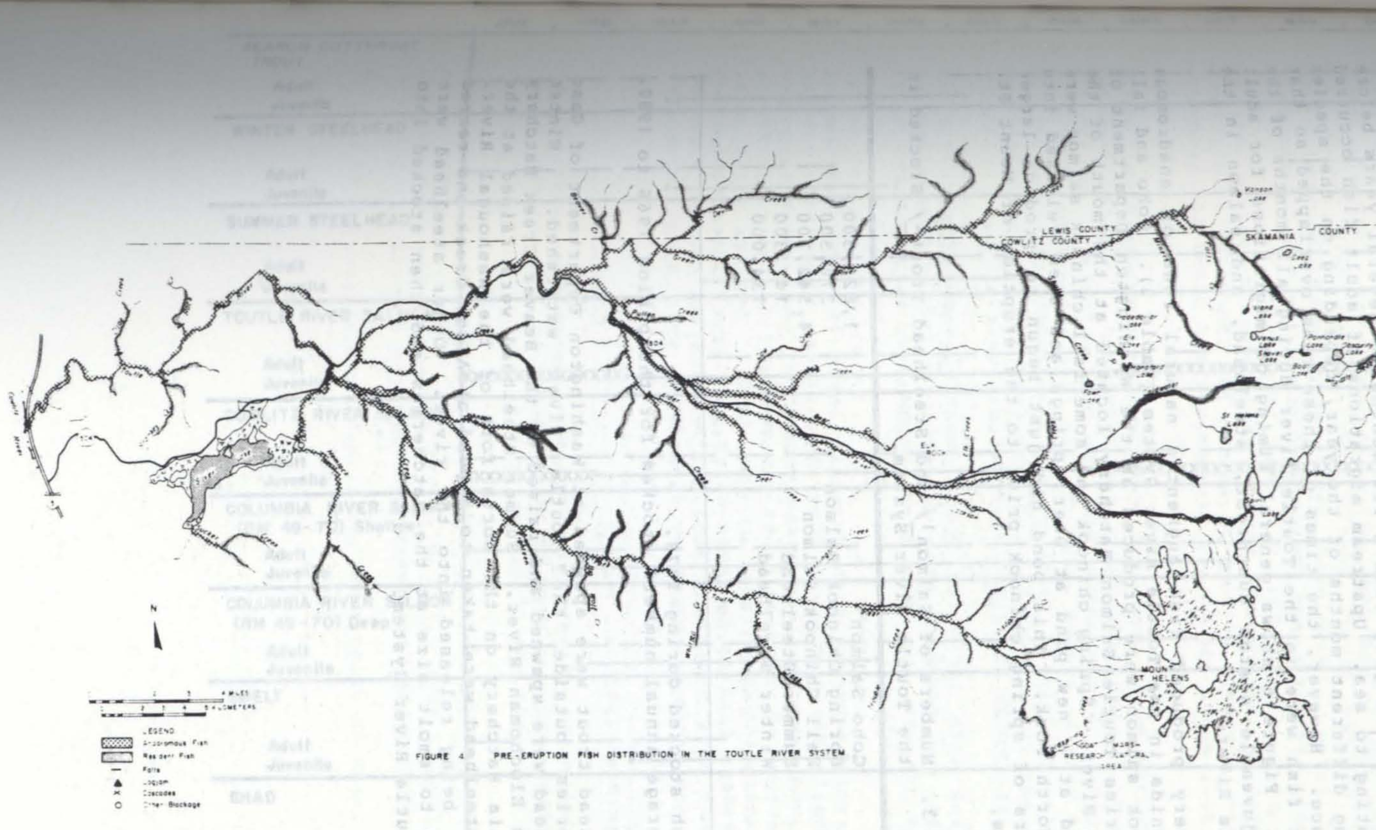


FIGURE 4 PRE-ERUPTION FISH DISTRIBUTION IN THE TOUTLE RIVER SYSTEM

Juvenile or adult anadromous fish were present in the Toutle River throughout the year. Juveniles remained in fresh water for periods ranging from a few months to several years before migrating to sea. Upstream migrations of adult fish occurred during different months of the year, depending on the species or race. However, the times of these runs overlapped so that adult fish were in the Toutle River during all months of the year. Figure 5 shows general timing of migrations for adult and juvenile searun cutthroat, steelhead, and salmon in the Toutle River.

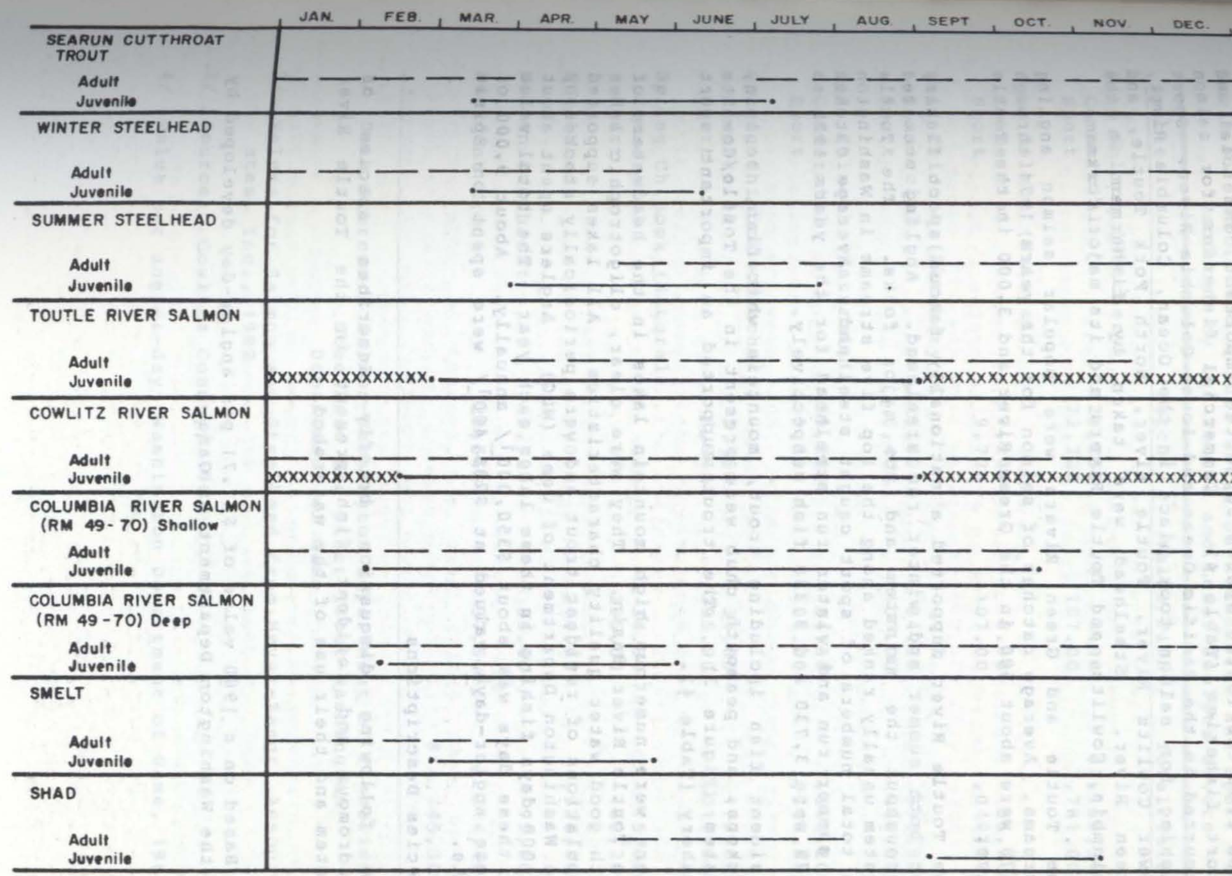
Hatchery produced fish augmented natural runs of anadromous salmonids in the Toutle River System (Table 3). Coho and fall chinook salmon were produced at the Washington Department of Fisheries Toutle Salmon Hatchery located at the mouth of the Green River. Spring chinook and some fall chinook salmon were reared at a new pond at Deer Springs and then released into the North Fork. This pond had just begun to produce larger numbers of spring chinook prior to the eruption of Mount St. Helens.

Table 3. Numbers of Salmon1/ and Steelhead Trout2/ Stocked in the Toutle River System.

Coho Salmon	1,821,300
Spring Chinook Salmon	376,500
Fall Chinook Salmon	4,542,300
Summer Steelhead	147,300
Winter Steelhead	134,000

1/ Fish stocked during 1978.
2/ Average annual numbers stocked for the period 1966 to 1980.

Steelhead trout were spawned at Washington Department of Game hatcheries outside the Toutle River watershed. Winter steelhead were spawned and raised at the Beaver Creek Hatchery on the Elochoman River. Summer steelhead were raised at the Skamania Hatchery on the north fork of the Washougal River. Some steelhead were taken to a pond at Alder Creek and reared before being released into the river. Other steelhead were reared to smolt size at the hatcheries and then stocked into the Toutle River System.



LEGEND

XXXXXXXX General presence

•———• / — — > Migration times

Figure 5. General presence of anadromous fish in project area.

Fish from the Toutle System supported important commercial and sport fisheries (Table 4). Commercial fisheries for salmon occurred in the Pacific Ocean and lower Columbia River. Sport fishing for salmon took place in the Ocean, Columbia River, lower Cowlitz River, Toutle River, North Fork Toutle, and Green River. Steelhead were taken by fishermen in the Columbia, Cowlitz, and Toutle Rivers and its major forks.

The Toutle and Green Rivers were popular salmon angling streams. Average catches of salmon for the years 1974 through 1978 were about 500 in the Green River and 3,000 in the Toutle River.

The Toutle River supported a nationally famous sport fishery for both summer and winter run steelhead. Angling occurred throughout the mainstem and its major forks. The Toutle System usually ranked among the top five streams in Washington in total numbers of sport caught steelhead. Average catches of summer run and winter run steelhead for the years 1975 to 1979 were 3,730 and 3,380 fish respectively.

Resident fish including trout, mountain whitefish, sculpin, suckers, and peamouth chub were present in the Toutle/Cowlitz System (Figure 3). The trout supported an important sport fishery (Table 4).

There were numerous high mountain lakes in the headwaters of the Toutle River Basin. They were clear, oligotrophic lakes with good water quality characteristics. All lakes supported populations of resident trout and were periodically stocked by the Washington Department of Game (WDG). Anglers spent about 11,000 days fishing in these lakes each year. The total value of these days was about \$350,000 1/ annually. About 9,000 of these angler-days valued at \$285,400 1/ were spent on Spirit Lake.

Species Descriptions

The following discussion briefly describes species of anadromous and resident fish present in the Toutle River System and their use of the watershed.

1/ Based on a 1980 value of \$31.71 per angler-day developed by the Washington Department of Game.

Table 4. Estimated Annual Value of Commercial and Sport Fish Produced by the Toutle and Lower Cowlitz Rivers

Species	Catch1/	Value/Fish2/	Total Value
Coho Salmon (Hatchery)			
Commercial	129,280	$ 8.98	$1,160,900
Sport	72,720	107.00	7,781,000
Coho Salmon (Natural)			
Commercial	17,280	8.98	155,200
Sport	9,720	107.00	1,040,000
Fall Chinook (Hatchery)			
Commercial	25,600	34.80	890,900
Sport	6,400	107.00	684,800
Fall Chinook (Natural)			
Commercial	39,200	34.80	1,364,200
Sport	9,800	107.00	1,048,600
Spring Chinook (Hatchery)			
Commercial	5,160	34.80	179,600
Sport	6,840	295.00	2,017,800
Spring Chinook (Natural)			
Commercial	430	34.80	15,000
Sport	570	295.00	168,200
Steelhead	9,000	214.00	1,926,000
Searun Cutthroat	2,750	36.003/	99,000
Resident Trout	28,560	37.504/	214,100
			$18,745,300

1/ Data Sources: Salmon-Washington Department of Fisheries
Steelhead and Other Trout-Washington Department of Game

2/ Values for Salmon and Steelhead from Meyer-Zangri Associates, Inc., 1982

3/ Source: Cowlitz County, 1982

4/ Value per angler-day (Washington Department of Game, 1980)

Spring Chinook Salmon: Historically, a small population of about 400 spring chinook salmon spawned in the upper reaches of the Toutle River. Some spring chinook were also present in the Green River downstream from Devils Creek (Keller, 1982). Adult fish normally entered the river between April and June and stayed in deeper pools during the summer. Sexually mature fish spawned in late summer and early fall. Juvenile fish normally spent 1 year in fresh water before migrating to sea.

A few years prior to the eruption of Mount St. Helens, the Washington Department of Fisheries (WDF) began a program to reestablish spring chinook in the Toutle System. Spirit Lake was stocked with 418,000 fingerling from the 1976 brood year. Spring chinook were also raised to the smolt stage at the Deer Springs rearing pond and then released into the North Fork Toutle River. A few spring chinook were also stocked in the South Fork Toutle.

Fall Chinook Salmon: About 6,000 fall chinook salmon spawned naturally in larger streams and some small tributaries within the Toutle River System annually. Most spawning occurred in the North Fork of the Toutle River from the mouth as far upstream as the mouth of Coldwater Creek. Other important spawning areas were located in the mainstem Toutle River; the lower 6 miles of the South Fork; and in Wyant, Outlet, Alder, and Hoffstadt Creeks. Juvenile fall chinook normally spent several months in fresh water before migrating to the ocean.

Coho Salmon: Two stocks of coho salmon (early and late run) were present in the Toutle River System. Early run coho, which entered the river in late summer, spawned mainly in smaller streams throughout the North Fork Toutle River drainage. Some also spawned in the South Fork and mainstem Toutle Rivers and their tributaries. Some of these fish migrated into Spirit Lake and spawned in some of its tributaries. Early run coho usually spawned after the first significant fall rains. Late run "Cowlitz" stock coho entered the Toutle River during October and November. These fish spawned in tributaries of both the North and South Forks.

Juvenile coho normally spent 1 year in tributary streams before migrating to the ocean. Streams in the Toutle River System contained excellent rearing habitat for juvenile coho salmon. Sampling done by the WDF showed that Castle and Maratta Creeks were the most productive streams for juvenile coho salmon in the Columbia River System (Dammers, personal communication).

Steelhead Trout: The Toutle River supported runs of both summer and winter steelhead, a migratory rainbow trout that spawns in streams, but spends much of its life in the ocean. Originally, the winter run was the most common race of steelhead present in the System. This run returned to the river from February through May. Summer run steelhead were rare, if present at all. The Washington Department of Game began to stock hatchery produced winter and summer run fish in 1953 and 1959, respectively, to increase steelhead runs.

Steelhead spawned from February to June in the larger streams and smaller tributaries. Juvenile steelhead remained in fresh water for 2 or 3 years before reaching smolt stage and migrating to the sea. Lower reaches of many streams that were covered by the mudflow or debris avalanche contained excellent steelhead spawning and rearing habitat. Hoffstadt, Bear, Alder, and Elk (Green River tributary) Creeks were the four most important steelhead spawning streams within the Toutle River System (Lucas, personal communication).

Searun Cutthroat Trout: Searun cutthroat trout inhabited most of the river system that was accessible to anadromous fish. Adult fish were present in the system from July to April and spawned in smaller streams in winter. The spawning population of searun cutthroat was estimated to be between 2,000 and 5,000 fish.

Resident Trout: Resident cutthroat, rainbow, and brook trout were present in lakes and streams throughout the upper watershed. Most of the lakes were periodically stocked by the WDG to provide sport angling.

Eruption

The May 18, 1980 eruption of Mount St. Helens destroyed nearly all of the fish life and much of the fish habitat within the main Toutle River System. A massive debris avalanche of 3 to 4 billion cubic yards of material covered 17 miles of the upper North Fork Toutle River. About 50 mcy of material filled the upper 4 miles of the South Fork Toutle River. Spawning and rearing areas were covered with ash or mud deposits ranging from 1 foot to nearly 600 feet in depth. Snow and glacial ice that were melted by the heat of the eruption combined with the avalanche and sent enormous mudflows down the North and South Forks of the Toutle River. These mudflows continued into the mainstem Toutle, Cowlitz, and Columbia Rivers.

Hot pyroclastic flows mixing with the mudflows raised temperatures to nearly 100° F more than 20 miles from the crater (U.S. Forest Service, 1981). In the North and South Forks of the Toutle, fish died of suffocation, heat, or loss of body fluids through gill abrasion caused by the large amounts of mud and ash in the water.

Adult anadromous fish present in the Toutle and Cowlitz Rivers at the time of eruption included spring chinook salmon, and winter and summer steelhead. Incubating eggs, fry, rearing juveniles, and smolts of all anadromous salmonids were also present. Resident trout, whitefish, and nongame fish were present throughout the system.

Many streams within the blast zone received large quantities of blowdown timber and thick layers of blast deposits. In other streams, debris washouts scoured channels to bedrock. Lower reaches of many tributaries were covered by mud and debris flows which obliterated old channels and forced streams to form new courses. Mudflows also backed up into many tributaries of both forks of the Toutle River and the Green River. The least affected streams received only ashfall deposits.

Within the Toutle River Basin about 135 miles (77 percent) of the streams used by anadromous fish were affected by volcano associated events. This included all of the larger streams (about 101 miles), and 34 miles (46 percent) of the accessible tributaries (Martin, personal communication). In addition, about 62 miles of resident fish stream habitat were affected in the Toutle River Basin. Many smaller streams were only slightly affected and continued to support juvenile salmonids after the eruption.

Forests surrounding many of the mountain lakes were destroyed. However, fish life in most lakes survived because of the protective layer of snow and ice that moderated the volcano's effects. Fish did not survive in Spirit, St. Helens, Boot, and Ryan Lakes (Lucas, personal communication).

The damming effect of the mudflow and debris avalanche also enlarged Spirit Lake and formed several new lakes and ponds. Coldwater Lake (805 acres) and Castle Lake (315 acres) are the largest of the newly formed lakes. Many of the other lakes were temporary and have filled with sediment (Crawford, 1983).

Post-eruption

Fish populations and stream habitats have recovered at differing rates depending on the severity of damage suffered, locations within the Toutle River System, and rehabilitation efforts that have occurred. Habitat conditions vary from poor in severely affected streams, such as the North Fork Toutle River, to average in streams that were affected only by ashfall.

Habitat recovery has not begun in stream reaches that were covered by the debris avalanche. The North Fork Toutle River and lower reaches of Hoffstadt, Bear, Maratta, Elk, Castle, Jackson, and Coldwater Creeks are examples of streams that were buried and are seeking new channels across the avalanche (Plate 1). All of these streams are unstable with shifting, braided channels that frequently change course during storm runoff. However, the WDF, in response to a Weyerhaeuser Company fish study, has stocked 15,000 coho this year (1984) in the upper reaches of Hoffstadt Creek. The North Fork of the Toutle River is now described by the Corps of Engineers as a sand-bedded stream where sediment transport is continuous (Plate 2). Little vegetation has grown in these areas. For example, no vascular plant growth has been observed along the South Fork of Coldwater Creek since the major eruption (McKee, personal communication).

Stream recovery has occurred slowly within the blast zone. Lower reaches of many Spirit Lake tributaries have shown no sign of vegetative growth along their shorelines and less than 1 percent vegetative cover in their upper watershed (McKee, personal communication). Many streams that were covered by volcanic material are beginning to reoccupy former channels in their steeper reaches. New channels are being formed in the lower gradient portions of these streams.

Lack of vegetation along Green River tributaries within the blast zone has resulted in high stream temperatures. Little, if any, woody vegetation has regrown in the Schultz Creek drainage, an area that was denuded by the major eruption (Mohoric, personal communication). Fish have been planted in this creek by WDF (as part of the above-mentioned Weyerhaeuser study), but the survival rate is not known. WDF also planted 250,000-300,000 spring chinook fingerlings in the Green River in 1984 (Mohoric, personal comm.).

Stream habitat outside of the blast and debris avalanche zone was less affected and has recovered at a faster rate. Many

Plate 1. Bear Creek was buried by the debris avalanche and is forming a new channel.

Plate 2. The North Fork of the Toutle River is now a braided, sand-bedded stream.

stream channels covered by ashfall or mudflows have scoured down to former streambeds. These streams have reformed pools and riffles. However, instream cover such as logs, undercut banks, and boulders has not yet reestablished. Alders along banks of these streams had regrown to a height of 2.5 feet by late 1982 (Mohoric, personal communication). They have now reached 5-6 feet in height in many areas (Mohoric, personal communication).

Other streams whose lower reaches were buried by mudflows that came down both forks of the Toutle River have formed new channels across the mudflows. In most cases, the new channels are fairly straight and uniform and often run parallel to the main forks of the Toutle before entering them. Bottom substrates of these streams are composed of boulders and cobbles. Streamside vegetation is generally absent.

Among the larger streams, the Green River and South Fork of the Toutle have recovered faster than the North Fork or mainstem Toutle Rivers. The Green River, which was affected by the blast and ashfall, has been rapidly flushed of sediment. Sediment yields appear to be returning to pre-eruption levels. However, lack of riparian vegetation in the upper watershed has caused high water temperatures in much of the Green River.

The South Fork Toutle River and its tributaries have also recovered rapidly. Much of the mudflow sediment has been flushed out and riparian vegetation has begun to grow along all the tributaries (Plate 3). High stream temperatures (near 80°F) were recorded in the lower South Fork during 1981 (Schuck and Kurose, 1982).

Fish have been found in many of the waters that they inhabited before the eruption. Figure 6 shows the present distribution of anadromous and resident fish in the Toutle River System.

Limited surveys done during 1980 showed that some anadromous fish returned to the Toutle River System. Adult summer run steelhead were captured in the North Fork as far upstream as the mouth of Alder Creek by July 1980. Coho salmon were later seen in Johnson Creek, a lower South Fork tributary (Keller, 1982). Many fish are thought to have strayed to other nearby Columbia River tributaries such as the upper Cowlitz, Kalama, Lewis, Elochoman, Grays, and Washougal Rivers.

Small numbers of anadromous fish returned to the Toutle River System during 1981 and 1982. Records for the South Fork

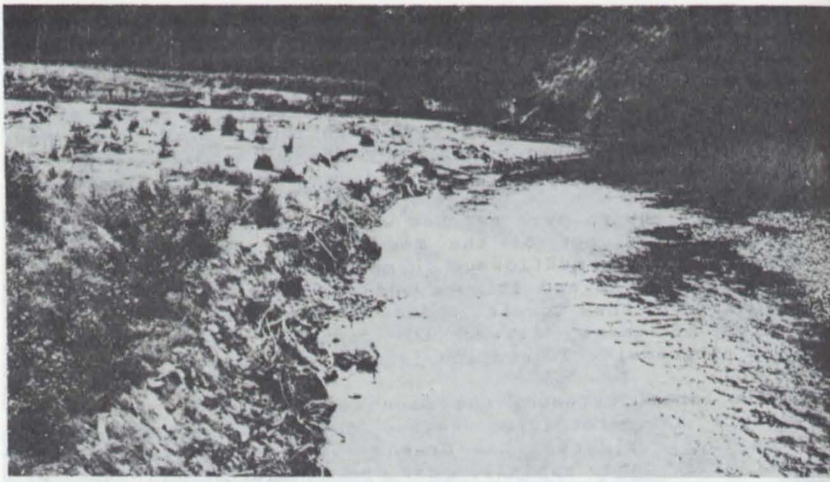


Plate 3. The South Fork of the Toutle River has flushed itself of sediment. Riparian vegetation is beginning to grow along this stream.

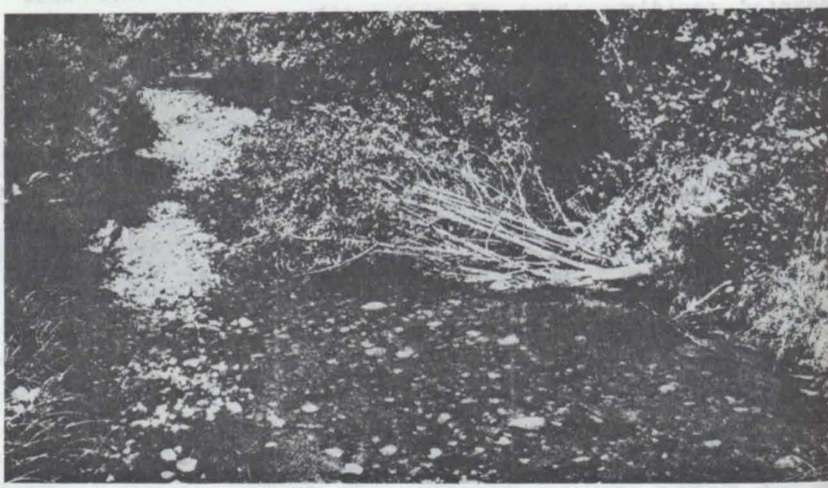


Plate 4. Alder Creek was affected by ashfall, but has recovered. Anadromous fish now use this stream.

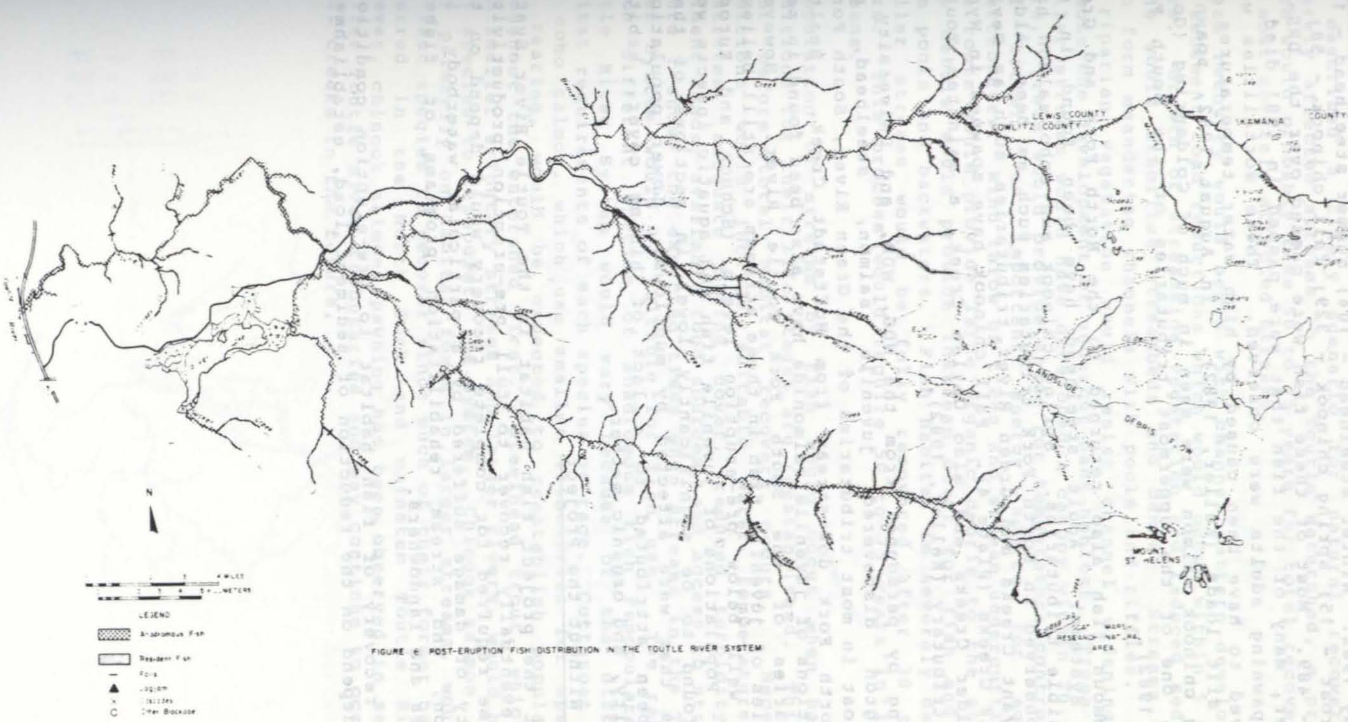


FIGURE 6: POST-ERUPTION FISH DISTRIBUTION IN THE TOUTLE RIVER SYSTEM

Debris Retention Structure (DRS-S1) fish trap showed that fish were returning to the South Fork Toutle River. The following numbers of fish were collected in this trap between April 1981 and May 1982: Winter steelhead - 104; summer steelhead - 153; cutthroat - 15; spring chinook - 329; fall chinook - 58; and coho - 489. Most of these fish were passed over the DRS-S1. However, many of the fish that were passed in 1981 died and few spawning adults were observed. These mortalities were believed to have been caused by high water temperatures and heavy silt loads (Keller, 1982). In August 1982, spawning spring chinook salmon were seen in much of Coldspring (Goat) Creek, one of the uppermost tributaries of the South Fork (WDF, 1982).

Anadromous fish also returned to the North Fork and Green River Systems. Adult steelhead have been found in all accessible tributaries. Spring chinook and coho salmon have been observed in North Fork tributaries such as Deer, Alder, and Wyant Creeks and Green River tributaries such as Devils and Elk Creeks (Plate 4). Fall chinook have spawned in Wyant and Alder Creeks and also Outlet Creek, a mainstem Toutle River tributary (Keller, 1982).

Sampling by personnel from the WDG, WDF, and University of Washington discovered juvenile salmon, steelhead, and cutthroat in most tributaries of the Green River, South Fork, and North Fork downstream from Hoffstadt Creek. Healthy populations of juvenile salmonids have also been found in many tributaries of the South Fork Toutle River. However, densities of juvenile fish in these streams are still believed to be well below pre-eruption levels (Schuck and Kurose, 1982). Populations of juvenile fish and aquatic insects were also found to be significantly lower in sections of these streams that were affected by mudflows. Lower populations have been attributed to a lack of hiding cover, habitat diversity, and organic matter.

Future Without the Project

Without the project fish habitat in the Toutle River System would eventually recover to full pre-eruption productivity. The time required for complete recovery would depend on the severity of damage suffered by a particular waterbody, its location, and stream rehabilitation programs of fishery agencies and landowners.

Future recovery of fish habitat to pre-eruption conditions would depend on the reduction of sediment load, establishment

of riparian vegetation, and development of fish cover structures such as boulders, logs, debris jams, overhanging vegetation and undercut banks (Martin, 1982). Martin (1982) has described a likely scenario for natural recovery of severely affected streams in the Toutle Watershed, a process which would probably take 50 to 75 years for total recovery in the most severely affected streams.

Stream recovery would begin with channel pattern development and sediment load reductions which would occur within 5 to 20 years. Growth of streamside vegetation and reduced sediment loads would stabilize streambeds and banks. Streams would then form meandering channels with pools and riffles. Roots of riparian vegetation would resist channel widening and promote the development of undercut bank habitat. Trees along smaller streams would have developed a canopy within 20 to 30 years. Trees would provide shade for temperature control and leaf litter, an important energy source for aquatic invertebrates. Wind throw of trees and stream undercutting of tree roots would provide large organic debris to the stream. This debris would provide instream cover for fish and help form pools and backwaters. Fish habitat in severely damaged smaller streams would be fully recovered after 30 to 50 years. This process would require 50 to 75 years in larger streams.

Repopulation of streams by fish would occur when habitat conditions for their life stages are reestablished. This may occur before total habitat recovery occurs. Necessary conditions would include suitable water temperature and substrates, adequate hiding cover, reduced turbidity and sediment loads, available food sources, and access to streams. Figure 7 shows the expected times when streams in the Toutle River System would be suitable for fish use. The rate at which different species of anadromous fish repopulate the Toutle River System would vary because of the differing habitat requirements of each species or race. Cutthroat trout and coho salmon, which use smaller tributaries for spawning and rearing, would be expected to reestablish populations throughout the watershed first. Steelhead trout, which use both smaller tributary streams and larger rivers, would be the next species to repopulate the System. Chinook salmon, which rely primarily on habitat found in larger streams, would be the last species to recover since much of their former habitat occurred in the North Fork and mainstem Toutle Rivers. However, chinook salmon spawning has been observed in several smaller Toutle River tributaries and may continue to occur in small creeks in the future.

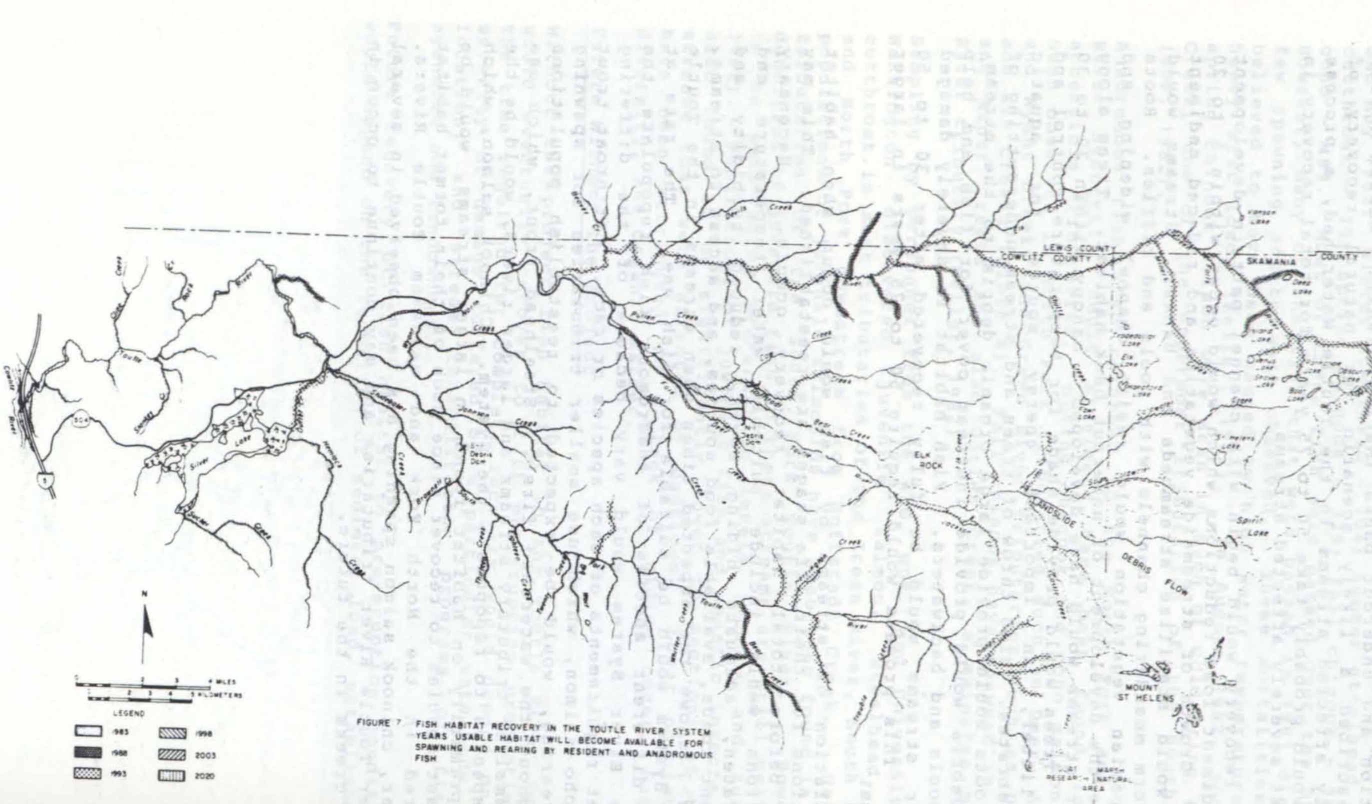


FIGURE 7. FISH HABITAT RECOVERY IN THE TOUTLE RIVER SYSTEM. YEARS USABLE HABITAT WILL BECOME AVAILABLE FOR SPAWNING AND REARING BY RESIDENT AND ANADROMOUS FISH

In general, streams that were least affected will recover most rapidly. Substantial recovery has already taken place in many streams in the Green and South Fork Toutle River drainages.

The South Fork Toutle and most of the Green River Systems are expected to be recovered and suitable for fish by 1988 and 1993, respectively. Table 5 shows the combined numbers of adult fish expected to be naturally produced by the Green and South Fork Toutle Rivers in the future.

Table 5. Projected Annual Number and Sport/Commercial Value of Wild Adult Salmonids Produced by the Green and South Fork Toutle Rivers

	Fall Chinook	Spring Chinook	Coho	Steelhead	Cutthroat
1983					
Number	150	200	250	250	150
Value	$6,350	$27,450	$9,700	$40,150	$3,600
1988					
Number	750	700	10,000	1,040	1,600
Value	$31,750	$96,150	$387,400	$166,900	$38,400
1993					
Number	850	700	12,000	1,040	1,600
Value	$36,000	$96,150	$464,850	$166,900	$38,400

Streams within the North Fork Toutle River Basin upstream from the mouth of the Green River are also recovering at varying rates. Two streams, Alder and Pullen Creeks, were not severely impacted and are now at pre-eruption conditions.

Tributaries that were covered by the debris avalanche and mudflow would require more time to recover because they would have to establish stable new channels and riparian vegetation. Formation of permanent channels would not begin until sediment yield from the debris avalanche has stabilized. Streams at the lower end of the debris avalanche such as Hoffstadt, Bear, and Deer Creeks would not be usable by substantial numbers of fish until 1998. Fish habitat in

severely affected streams higher in the debris avalanche would not be restored until 2003, while the North Fork Toutle would not be usable for spawning or rearing until 2020. Total recovery of these streams would require between 50 and 75 years from the date of the eruption. These streams include Maratta, Castle, Coldwater, Elk, and Jackson Creeks.

The North Fork and mainstem Toutle Rivers would show substantial recovery after 35 years when the debris avalanche becomes stabilized. Complete recovery of these rivers would require an additional 15 to 40 years.

Fish stocks in the North Fork Toutle drainage are presently at a very low level. Populations of all species would gradually increase during the next 15 years as habitat conditions improve in various tributaries. Full production should be realized by 2020 when all streams have shown substantial recovery. Recovery rates for fish populations in the upper North Fork and their associated monetary values are shown on Table 6. Methods and calculations used to develop these predictions are shown in Appendix A.

The Washington Departments of Game and Fisheries plan to reintroduce anadromous fish into the Toutle River System as streams become suitable. The South Fork was stocked with steelhead in 1981, 1982, 1983, and 1984; the North Fork in 1982; and the Green in 1982, 1983, and 1984. The Green River and South Fork Toutle and their tributaries were stocked with coho and spring chinook salmon in 1983 and 1984. Both river systems would continue to be stocked with salmon and steelhead in the future. The WDF has also stocked coho salmon in Alder Creek, a North Fork tributary. Spring chinook would be stocked in Beaver Slough (on the Green River) in the spring of 1985.

Future With the Project

No Action

About 400 mcy of bedload and 200 mcy of suspended load would enter the Columbia River over a 50-year period. About 50 mcy of gravel would remain in the Toutle River. Over the long-term, slow recovery of stream habitat in the Toutle and North Fork Toutle River Systems would occur. Reestablishment of accessible habitat, including riparian vegetation, would mean the return of anadromous fish runs and the opportunity to provide for enhancement of these fish through natural or hatchery production. Prolonged turbidity and continued

Table 6. Projected Annual Number and Sport and Commercial Value of Wild Adult Salmonids Produced by the North Fork Toutle River System Upstream from the Mouth of the Green River

	Fall Chinook	Spring Chinook	Coho	Steelhead	Cutthroat
1983					
Number	50	20	100	50	50
Value	$2,100	$2,740	$3,850	$8,025	$1,200
1988					
Number	75	50	150	150	250
Value	$3,150	$6,850	$5,775	$24,075	$6,000
1993					
Number	125	150	650	250	400
Value	$5,250	$20,500	$25,025	$40,125	$9,600
1998					
Number	2,000	200	1,030	450	600
Value	$84,000	$27,450	$39,650	$72,225	$14,400
2020					
Number	15,800	500	18,900	2,050	2,800
Value	$663,600	$68,500	$727,650	$329,025	$67,200

channel changes and streambank instability, however, would reduce the survival rate and successful spawning of adult salmonids for many years. Little or no sport fishery would occur in the North Fork Toutle River, even after habitat recovery.

No Action With Interim Measures (Public Law 98-63)

This alternative is basically a non-structural alternative. Dredging would occur at two sites, LT-1 and LT-3 (Figure 2) to satisfy the PL 98-63 requirements to maintain a 100-year flood plain. If no structures are built, dredging would be continuous over a period of 8 years with reduced dredging for

the next 25 years. If an upstream dam is constructed, dredging at the LT-1 and LT-3 sites would continue, but at a reduced level.

Only 50 to 80 percent of bedload material would be trapped and removed with this alternative. The remaining material and all suspended load would pass through to the Cowlitz and Columbia Rivers. A significant problem associated with this alternative is the need for long-term disposal sites. Approximately 29 mcy of material would require disposal, much of which would be placed on valuable wetland riparian habitat. Problems with fish passage at the interim dredging sites would also be experienced. The beneficial aspects of this alternative, i.e. reduction in sedimentation and maintenance of passage for anadromous fish to upstream tributaries, are outweighed by the negative impacts on fish habitat from continued dredging and loss of riparian/wetland habitat.

Multiple Retention Structures (MRS)

This alternative involves structures (at the LT-3, Kid Valley, and Green River sites, (Figure 2) which would be constructed at varying times over the next 10 years. The LT-3 Dam would be constructed first and the Green River Dam last. The lowermost dam at LT-3 would effectively eliminate nearly all of the Toutle River System's existing and potential anadromous fish production. Construction of each succeeding structure (Kid Valley and Green River Dams) would result in further destruction of fish habitat. Sediment and debris accumulating behind each dam as it is constructed would back up into tributary streams and block any potential anadromous fish migration, instream food production, and development of riparian vegetation. Resident fish would also be adversely affected by this blockage.

Single Retention Structure (SRS)

A single dam placed at any of the above sites would have similar impacts. Each of the single retention structures is discussed in more detail below:

<u>LT-3 Site</u>: This alternative (elevation 330) would reduce sedimentation in the Toutle River downstream of the structure until the impoundment area was filled (in about 4 to 5 years). Downstream water turbidity would improve during this period, as would spawning and rearing of fish in the lower Toutle River. But once the LT-3 impoundment area was filled, this advantage would be eliminated.

summer water temperatures in the Toutle River could be elevated by the increased retention time of shallow water behind the dam. Retention time of greater than 30 days is considered critical to downstream water quality. Preliminary figures indicate that surface water temperature of the impounded pool during June to October would be 1 to 2 degrees higher than the inflow temperature. Depending on the mode of release of this water, downstream water temperatures could be adversely effected.

Anadromous fish production valued at about $2,661,000 annually would be eliminated permanently from all waters upstream of this structure. Existing and potential fish habitat for anadromous and resident fish in portions of the Toutle River and many of its major tributaries would be covered with sediment. Sediment buildup behind this structure would impact as much as 2,250 acres (Table 7).

Table 7. Sediment pool sizes with alternative sites and elevations.

SITE	SLOPE	ELEVATION	ACRES
LT-3	S=0.004	275	1,040
	S/2=0.002	300	1,700
		330	2,250
Kid Valley	S=0.008	665	590
	S/2=0.004	700	1,400
		745	2,240
		780	3,240
		855	5,775
Green River	S=0.012	865	860
	S/2=0.006	900	2,012
		930	2,950
		965	3,825
		990	4,291
		1,060	5,560

Kid Valley Site: The effects of this alternative on downstream water quality and water temperatures are similar to those described for the LT-3 site. The shallow pool behind this structure is projected to be 3 degrees warmer than the inflow temperature in August. The 64°F projected temperature

approaches the upper limit established by Washington State law. Releases from the dam could, therefore, negatively impact mainstem Toutle waters.

Anadromous fish passage to the Green and upper North Fork Toutle Rivers would be blocked. The value of this annual fish loss is approximately $2,260,000. The option to re-open the Toutle Salmon Hatchery on the Green River would be foregone. This would mean a loss in production of approximately 6 million coho and fall chinook salmon fry. Sediment deposition in the Green and upper North Fork Toutle Rivers would block access to the upstream fish habitat in these rivers. Sediment deposits upstream of this structure would cover 2,240 acres (Table 7).

<u>Green River Site</u> (Preferred Alternative): Future sedimentation in the North Fork Toutle River downstream of the dam would be reduced by about 299 million cubic yards within 50 years after completion of construction. Opportunities to fish for salmon and steelhead in downstream areas would be restored sooner and in a greater number of sites with this alternative than with a dam located at the LT-3 or Kid Valley sites. As a result of reduced sedimentation and controlled flows, riparian vegetation would reestablish sooner along the lower portion of the North Fork and mainstem Toutle River than with either the LT-3 or Kid Valley sites or the no action alternative. These latter effects would help significantly to reestablish salmonid fish runs in areas downstream of the dam. Depending on future habitat restoration, salmonid fish runs supporting an annual catch of 335,000 valued at about $18,500,000 annually would eventually return to the Toutle and lower Cowlitz Rivers. However, there are no specific data to confirm when the areas downstream of the dam would recover enough to support such populations.

Anadromous fish runs in the upper North Fork Toutle River, and in its major tributaries such as Alder, Pullen, Deer, Hoffstadt, and Bear Creeks would be eliminated for many decades under this alternative (Figure 8). The area impacted by sediment deposits amounts to about 3,825 acres (Table 7). Salmon and steelhead would also be prevented from reestablishing in Spirit Lake and its tributaries because of the lake's outlet tunnel. Fish losses in Spirit Lake are considered to be offset by downstream benefits of the Spirit Lake project but, due to the tunnel location, an additional 5 miles of the North Fork Toutle, valued at $259,000 annually, would be eliminated. Annual losses for anadromous fish equate to about $1,858,000. Resident trout populations and habitat upstream of the dam would also be severely depressed in many of the upper North Fork Toutle River tributaries. Opportunities for angling upstream of the dam would also be foregone.

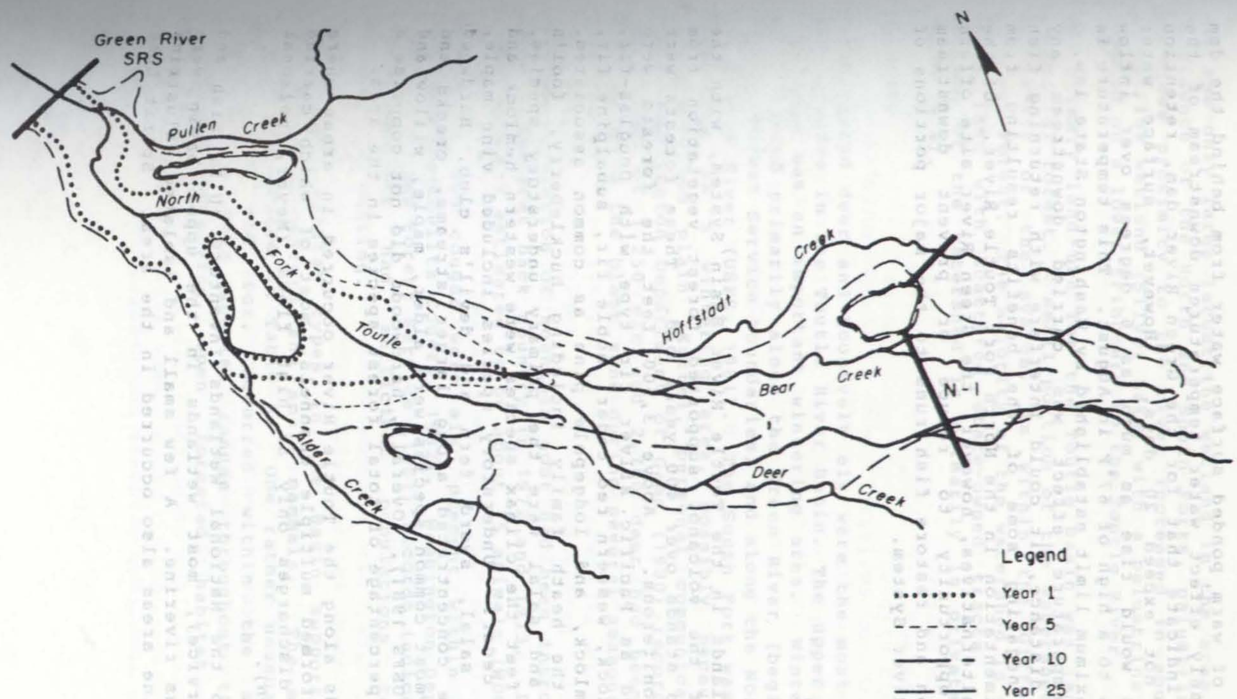


Figure 8. Sediment accumulation upstream of the Green River SRS.

The release of warm ponded surface water from behind the dam could adversely effect water temperatures downstream of the dam. Data indicate that for the Green River dam, retention time would not exceed 20 days. However, surface water temperatures would rise as much as 6 degrees over inflow temperatures to a high of 67°F in August. This temperature is above the maximum limit established by Washington State law. If this temperature effect was carried downstream any significant distance, it could interfere with returning fish runs, thus negating some of the benefits resulting from reduced sedimentation in the North Fork Toutle River. Of the structural alternatives, however, the Green River site offers the best opportunity to reduce or prevent downstream sedimentation and restore fish runs to the major portions of the Toutle River System.

WILDLIFE

Pre-eruption

Habitat

Almost all lands in the Toutle River Basin System, with the exception of the volcano, supported forest vegetation from seedlings to stands over 400 years old. These forests were primarily coniferous. Above 3,500 feet the forests were characterized as Pacific silver fir type with Douglas-fir, western hemlock, western red cedar, noble fir, subalpine fir, mountain hemlock, and lodgepole pine as common associates. Members of the heath family including huckleberry, fool's huckleberry and salal were the primary understory species. Below 3,500 feet the climax species were western hemlock and western red cedar. Understory species included vine maple, huckleberry, salal, sword fern and devil's club. Hardwood species were concentrated along larger streams, creeks and rivers. The most common species were alder, maple, willow and cottonwood (USFS 1981). Overall, hardwoods did not comprise a significant percentage of total forest species in the area.

Most wetlands along the Toutle River occurred in areas where the stream formed multiple channels, most of which carried significant discharges only at high flows (Meyer, personal communication).

According to the National Wetlands Inventory (U.S. Fish and Wildlife Service), most wetlands in the upper basin were classified as riverine. A few small and isolated palustrine and lacustrine areas also occurred in the area. Spirit Lake

was the only large lacustrine wetland in the area. Near the confluence of the North and South Forks, palustrine wetlands in close proximity to the river increased in abundance. A lacustrine wetland (Silver Lake) with a palustrine fringe was located on a lower tributary to the Toutle River.

The primary land use for the Toutle Basin was (and remains) commercial forest. A small portion of the watershed, near the headwaters of the system, is within the Gifford Pinchot National Forest. The majority of the watershed is corporately owned land with scattered state-owned tracts. The lower portion of the watershed is primarily in private ownership (USDA 1974).

Wildlife

Black-tailed deer and Roosevelt elk were the most common big game species in the Toutle River Basin. The upper portion of the basin was an important wintering area. Wintering areas were located primarily along the Green River (beginning just outside Forest Service boundaries) and along the North Fork of the Toutle River (USFS, 1981). The South Fork was of lesser importance as a wintering area, possibly because of the narrower flood plain (Kuttel, personal communication; WDG, 1978). Washington Department of Game (1980) records indicate an average of 1,250 elk and 2,700 deer had been harvested annually from the blast zone during several seasons preceding the blast.

A small population of mountain goat had been introduced into the Mt. Margaret back country in 1972 and 1973. In 1978 the population was estimated to be about 15 animals (WDG, 1978).

Black bear and cougar were also present within the Toutle River Basin (Cowlitz County, 1982). Washington Department of Game (1975) and Forest Service (1981) records indicate both of these species had sufficient populations to support recreational hunting.

The diverse habitat types in the Basin supported a wide variety of furbearers and small mammals. The more common species are listed in Table 8. One rather unusual species, the Cascade red fox, occurred within the study area (WDG,1979). This species ranges throughout the Cascade Mountains, occupying open forested habitat near the timberline.

Table 8. Common Species of Small Mammals and Furbearers Found in the Toutle River System.

Common Name	
Opossum	Muskrat
Shrews	Pacific jumping mouse
Moles	Porcupine
Bats	Red fox
Pika	Coyote
Snowshoe hare	Raccoon
Mountain beaver	Marten
Hoary marmot	Fisher
Townsend chipmunk	Mink
Western gray squirrel	Long-tailed weasel
Douglas squirrel	Ermine
Northern flying squirrel	Striped skunk
Beaver	Spotted skunk
Mice	River otter
Dusky-footed wood rat	Bobcat
Voles	

The Toutle River Basin was not considered to be an important waterfowl area. As a result, specific waterfowl use information is lacking. No known surveys were conducted in years directly preceeding the blast. More common species which may have used the basin include mallard, American wigeon, teal, and merganser.

Upland game birds found in the area included ruffed and blue grouse (USFS, 1981). Ruffed grouse usually occur in deciduous forest or mixed deciduous and coniferous forests characterized by variations in successional stages with nearby clearcuts or fields (Brewer, 1980). Blue grouse are common in more mountainous areas in association with coniferous forests, clearcuts, brush, and meadows.

Birds of prey which occurred within the project area include spotted owl, barred owl, western screech-owl, northern saw-whet owl, great horned owl, red-tailed hawk, sharp-shinned hawk, Cooper's hawk, goshawk, kestrel, merlin, osprey, and bald eagle (USFS, 1981). Spotted owl habitat occurred along the upper Green River watershed in old growth stands near Goat Mountain (USFS, 1981). Bald eagle and osprey nested along Spirit Lake (Roberts, personal communication).

The diverse habitat types within the Toutle River Basin supported a wide variety of bird species. A small population of white-tailed ptarmigan occurred above timberline on Mount St. Helens (Roberts, personal communication). Woodpeckers, such as downy, hairy, black-backed, and three-toed; and other cavity excavators such as the red-breasted sapsucker and the red-breasted nuthatch occurred throughout old growth and snag areas. Riparian and upland sites provided habitat for a wide variety of passerines and other songbirds including sparrows, finches, warblers, swallows, swifts, vireos, thrushes, wrens, blackbirds, jays, chickadees, nuthatches, crows, ravens, and hummingbirds (USFS, 1981).

Eruption

The blast of the Mount St. Helens eruption was directed in a 120° arc on the north to northeast side of the mountain. The force of the explosion and hot gases completely destroyed all forests for a radius of 8 miles from the mountain. For another 5 miles outside of this zone, old growth was uprooted and knocked down; smaller vegetation was killed. Outside this zone, up to a distance of 20 miles from the volcano, hot air and gases killed the vegetation (Cowlitz County, 1982). The upper portion of the watershed was blanketed with 1 to 4 inches of ash and tephra.

The loss of old growth habitat (along the Green River) was probably the most serious long-term damage to wildlife habitat resulting from the blast. It was particularly damaging to the spotted owl, although a wide variety of avian and mammalian species also utilized this habitat.

Deer and elk winter range along the North Fork and along the Green River was heavily impacted by the eruption and associated mudflows (USFS, 1981). Riparian vegetation, particularly understory species, was damaged by the mechanical force of the mudflow and by burial. Vine maple was the most heavily impacted, followed by Western red cedar, red alder, and Western hemlock (Chapman, 1981). All of these species have high palatability for elk (Murie, 1951).

It was assumed that all wildlife within the blast zone died. The Washington Department of Game (1980) estimated that approximately 5,000 elk and 6,000 deer were killed as a result of the eruption. The entire mountain goat population was destroyed. Approximately 200 bear and 15 cougars were killed. Some burrowing mammals probably survived in portions of the blast zone beyond the areas of complete devastation.

The white-tailed ptarmigan population was probably destroyed (USFS, 1981).

Furbearer and upland game losses estimated by the Washington Department of Game are shown in Table 9.

Songbirds appeared to be particularly affected by the blast. Ashfall accounted for a number of problems including respiratory distress, reduced food sources (insects in particular), and lowered nesting success (USFS, 1981).

Table 9. Estimated Furbearer and Upland Game Losses in the Toutle River System (WDG, 1980).

Species	No. of Animals
Beaver	1,016
Muskrat	2,714
Otter	186
Mink	504
Coyote	1,411
Raccoon	1,181
Marten	710
Bobcat	300
Rabbit/Hare	11,300
Grouse	27,750
Pigeon	8,500

Post-Eruption

Habitat

A wide variety of habitat conditions exist within the watershed. Some areas were severely impacted and in some cases vegetation was completely destroyed. Other areas were relatively unaffected by the blast. Existing habitat types at the proposed SRS are shown in Figure 9. Extensive natural and artificial revegetation is occurring in areas affected by the blast and associated mudflows. Generally, vegetation recovery has been vigorous, a situation which is apparently not unusual at volcanic sites (Nichols, 1963, cited by FS, 1981; Anderson, personal communication).

Areas impacted by debris flow, pyroclastic flows, or steaming mudflows were completely destroyed and have not yet

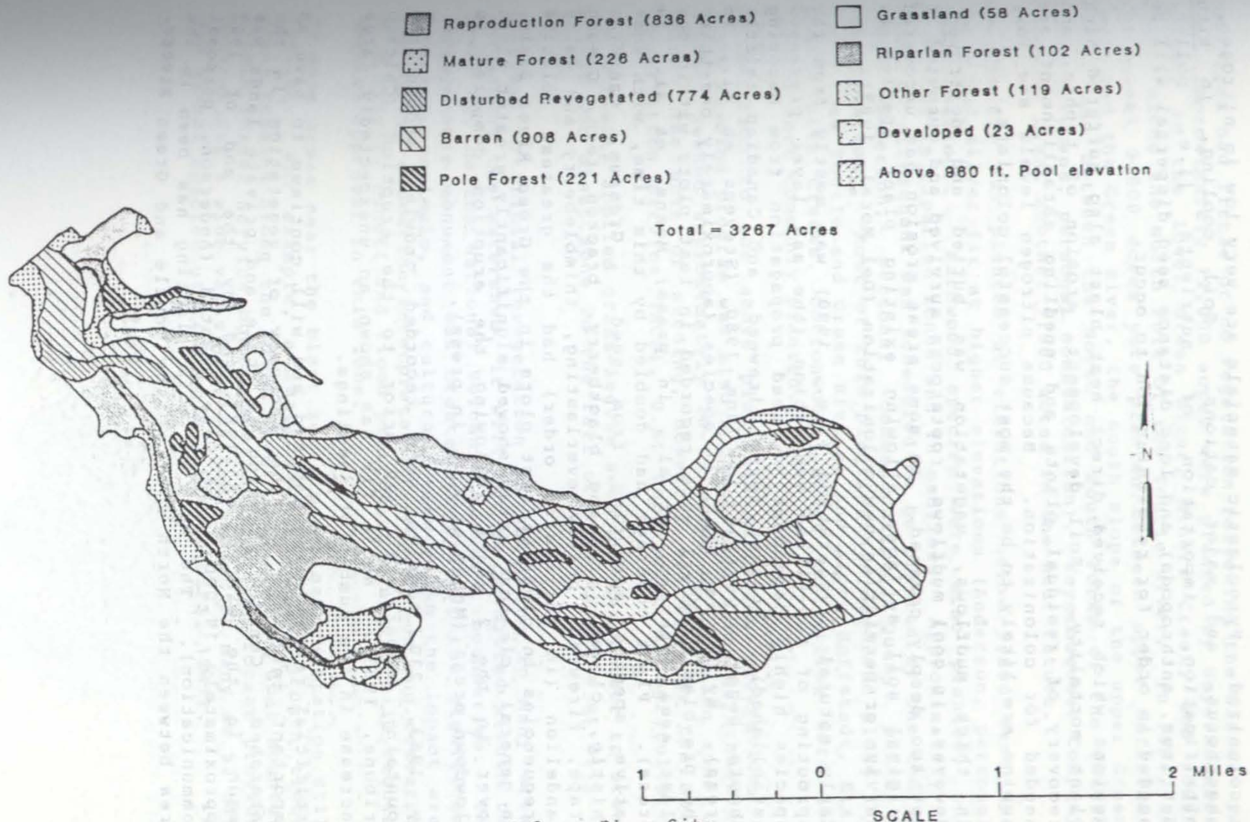


Figure 9. Post-eruption Habitat Types at Green River Site.

recolonized. Pyroclastic materials are very low in nitrogen, phosphorus, and major cations. Soil cooling, in situ nitrification, importation of nutrients (i.e. pollen, detritus, anthropods) and long distance seed dispersal will be needed in order for recolonization to occur.

Regions which received direct heat blast also suffered high plant mortality. Soil development, erosion of tephra, and recovery of residual plants and seedling establishment are needed for colonization. Because nitrogen levels are low, lupine are likely to be the most successful colonists.

In thick mudflows, vegetation was buried and destroyed. However, in cool mudflows, rootstocks survived and sprouted if not too deeply covered. In some areas erosion has uncovered original soil surfaces allowing existing plant species to survive or permitting new colonization (Del Moral, 1983).

Early natural revegetation (i.e., 1980) was mostly from the sprouting of top-killed vegetation (the ash layer prevented species highly dependent on seed propagation from becoming established). Bracken fern, fireweed, and Canadian thistle shoots began appearing in June 1980 (Stevens et al., in press). By October 1981, 31 species (approximately one-third the pre-blast number) were recorded in test plots within the blast area (Stevens, et al., in press; Means, et al., in press). Plant coverage had doubled by this time, with some native species sprouting from seed. Grasses, Canadian thistle, clover, trailing blackberry, bracken fern, Oregon grape, fireweed, pearly everlasting, thimbleberry and false dandelion (in decreasing order) had the greatest relative frequencies in clearcut test plots in the Green River Basin. In general, clearcut areas showed significantly greater plant cover in the 2 years following the eruption compared to blowdown areas (Means et al., in press).

By 1983, 230 species were recorded growing around the mountain; compared to 300 prior to the eruption (Chicago Tribune, 1983). Noble fir has shown an unexpectedly large increase in the number of seedlings.

Artificial revegetation has had and will continue to have an important influence on the recovery of vegetation in the watershed. Conifer planting on state and private lands was begun in the winter of 1981 and by the end of 1982 approximately 19,000 acres were planted (Anderson, personal communication). The bulk of this planting has been in the area between the North Fork of the Toutle and Green Rivers.

This area had little or no vegetation following the blast. In 1983, approximately 12,000 acres were planted by Weyerhaeuser Company in the lower Green River, Miners Creek, and south slopes along the North Fork of the Toutle River. In 1984, an additional 9,000 acres were planted between upper Hoffstadt Creek and the Green River, the south slope of the upper Green River, and between the North and South Forks of the Toutle River (Stevens, personal communication). Weyerhaeuser Company plans to plant another 9,000 acres in the near future.

Douglas-fir was planted at elevations below 3,000 feet and noble and silver fir at higher elevations (Anderson, personal communication). Hardwood species were also planted, but primarily in riparian zones and in mudflows. Approximately 45 miles of streambank was scheduled to be planted by the end of 1982 (Anderson, personal communication; Quan, personal communication). Most of this planting has occurred along the North Fork Toutle and Green Rivers, and along Hoffstadt, Elk, and Schultz Creeks. Cottonwood, alder and willow were the species most commonly planted.

In addition to the above plantings of woody vegetation, a grass seeding program was also accomplished. The Weyerhaeuser Company seeded approximately 10-13 miles of riparian zone in 1980. The bulk of seeding, however, was done by the Soil Conservation Service (SCS), U.S. Department of Agriculture.

SCS aerially applied grass-legume seed and fertilizer to areas within the blast zone in the fall of 1980 (Stevens et al., in press).

Although artificial revegetation is occurring in many areas throughout the watershed, it will not be permitted within the Mount St. Helens National Volcanic Monument boundaries. The 110,000-acre monument was created to protect the significant geologic, ecologic, and cultural features in the impact area for public education/interpretation, recreation and research. As a result, runoff and flood protection measures will require special approval in this zone.

In some areas near the blast zone, pre-blast vegetation still remains. For example, a small amount of old growth timber still remains along the Green River just west of Goat Mountain within Forest Service boundaries. Old growth forest provides habitat for a wide variety of vertebrates. As many as 52 bird and mammal species utilize this habitat (USFS, 1981).

Snag habitat was created on the edge of the blast zone by thermal effects. During salvage operations the Washington Department of Natural Resources and the U.S. Forest Service have left snags standing in small tracts along the Green River and Miners Creek. This habitat is utilized by as many as 83 species of birds and mammals.

New wetlands are beginning to develop in the basin. Conditions along the Toutle mainstem and North Fork indicate that two major wetland types could develop. These include: 1) a wide flat valley bottom type with multiple stream channels which are regularly inundated by flood waters; and 2) a flood plain type which receives tributary flow either as surface flow or groundwater (Meyer, personal communication). The Toutle River and North Fork of the Toutle River have aggraded with nearly every major storm in 1981 and 1982. This has led to channel configurations of the first type in many reaches.

Deposition in areas where a broad flood plain exists as a result of the May 1980 and March 1982 debris flows has created marshy conditions. Areas along the south bank of the Toutle at RM 4 and the north bank of the North Fork at RM 3 are examples. Tributary surface and groundwater flow, as well as precipitation, has probably been the source of water in these locations. If aggradation continues, flooding flows will also contribute to the water budget of these wetlands.

In mudflow areas along the river bottoms, dense 2- to 3-foot-high alder thickets are growing. Although Weyerhaeuser Company has planted cottonwood in some of these same areas, they have in many cases been crowded out by the alder (Meyer, personal communication).

During emergency actions following the eruption, sediment stabilization basins (LT-1 and LT-3) were used as sediment traps in the lower Toutle River. Habitats remaining in these areas are shown in Figures 10 and 11. Habitat descriptions are contained in Appendix B.

Wildlife

Elk are returning to the blast-affected area as vegetation recovers. In the fringe areas of the blast zone, landowners have had some difficulty re-establishing vegetation because of elk browsing (Kuttel, personal communication; Anderson, personal communication). Elk within the Mount St. Helens area have been observed in a wide range of vegetation types during

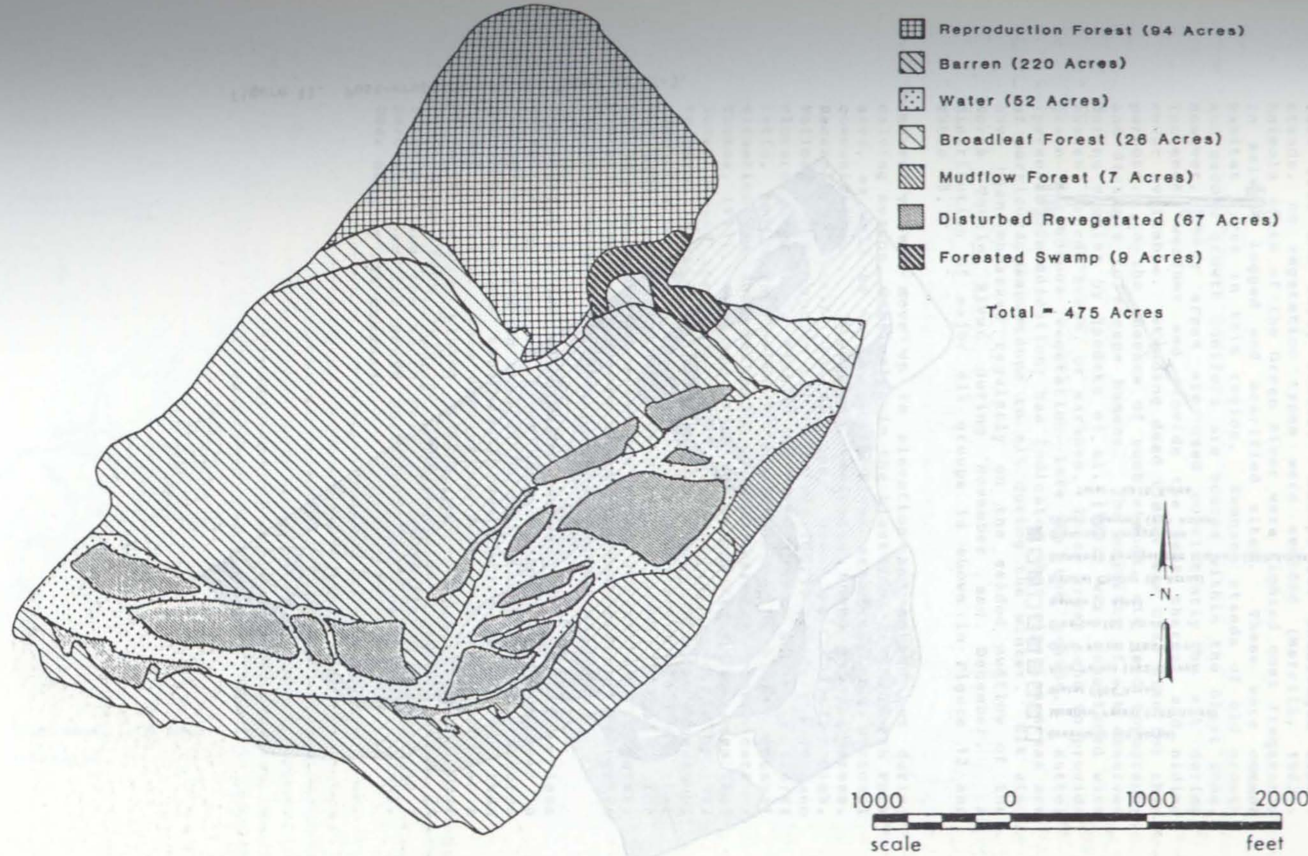


Figure 10. Post-eruption Habitat Types at LT-1.

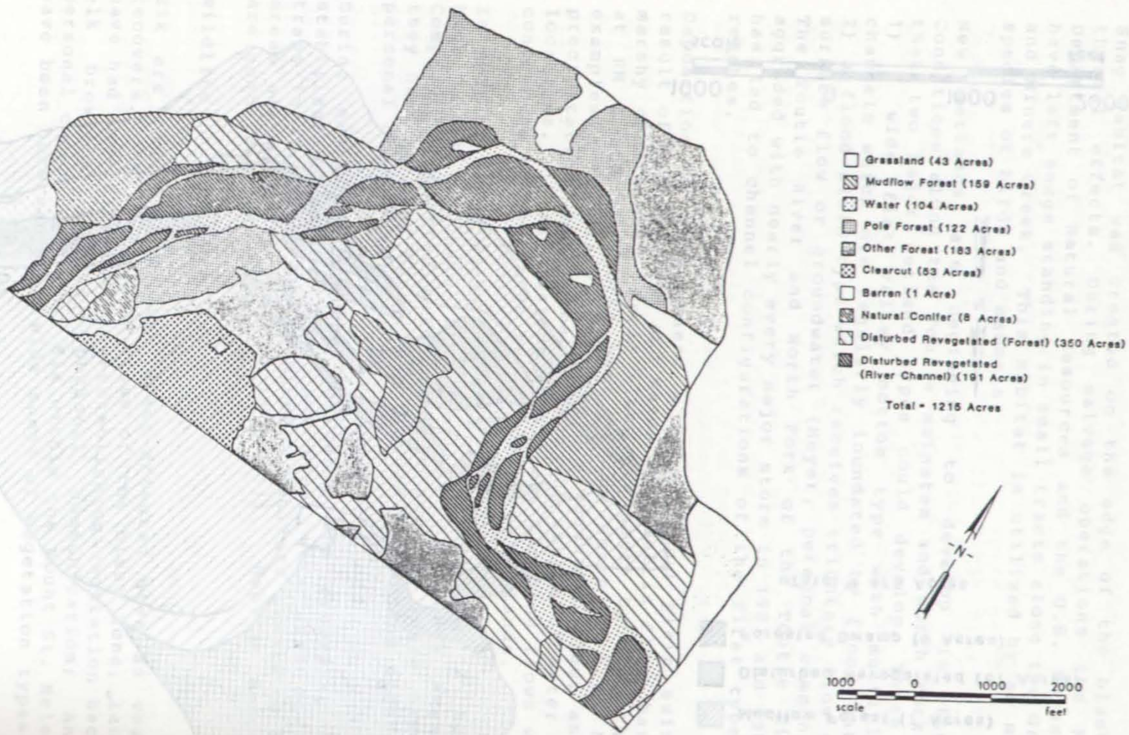


Figure 11. Post-eruption Habitat Types at LT-3.

late fall and early winter. Except for unsalvaged timber stands, no vegetation types were avoided (Merrill, 1982). Animals south of the Green River were sighted most frequently in salvage logged and scarified sites. These were common habitat types in this region. Remnant stands of old growth and second growth conifers are scarce within the blast zone. However, these areas are used consistently by elk during inclement weather and provide the best thermal and hiding cover available. Standing dead timber was used also for this purpose. In the absence of such stands, elk used topography and distance to escape humans. The majority of elk observed during studies by Raedeke et al. (1982) were associated with swales, ground seeps, or marshes. These areas tend to provide green herbaceous vegetation late in the season. Kuttel (personal communication) has indicated that riparian areas are of particular importance to elk during the winter. Elk also have been observed regularly on the seeded mudflow of the North Toutle River during November and December. A distribution of major elk groups is shown in Figure 12 and Table 10.

Generally, elk move up in elevation and spread out during calving season. Cows calve in the blast zone in the North Fork area, as well as in the Green River area (Merrill, personal communication). Figure 12 indicates known calving areas. Recently cow:calf ratios have been particularly high. Following the eruption the ratio was 100:32 inside the volcano closure zone (WDG, 1980). The 1981 season showed a 100:64 ratio, indicating twinning is occurring; a highly unusual situation for Roosevelt elk (Kuttel, personal communication; Thomas, 1983). With the exception of the restricted area (Red Zone) around the volcano, elk recovered sufficiently by 1982 to permit hunting again in the blast area (Stoddard, personal communication). Kuttel (personal communication) believes that the past two mild winters have reduced winter mortality for elk even though good wintering areas are scarce. However, winter forage is likely to be an important limiting factor in the near future (Anderson, personal communication).

Information on deer population changes and movement is less extensive than for elk. No deer carcasses were observed in the spring of 1980 on regular carcass census routes. Records for 1980 indicate that adult:fawn ratios were lower than normal (100:37). This decline may have been the result of a previous severe winter (1979) and the eruption. Deer populations from 1979 to 1982 were down approximately 74 percent along the North Fork of the Toutle River, and up 8 percent along its South Fork (WDG, personal communication). Deer hunting has resumed.

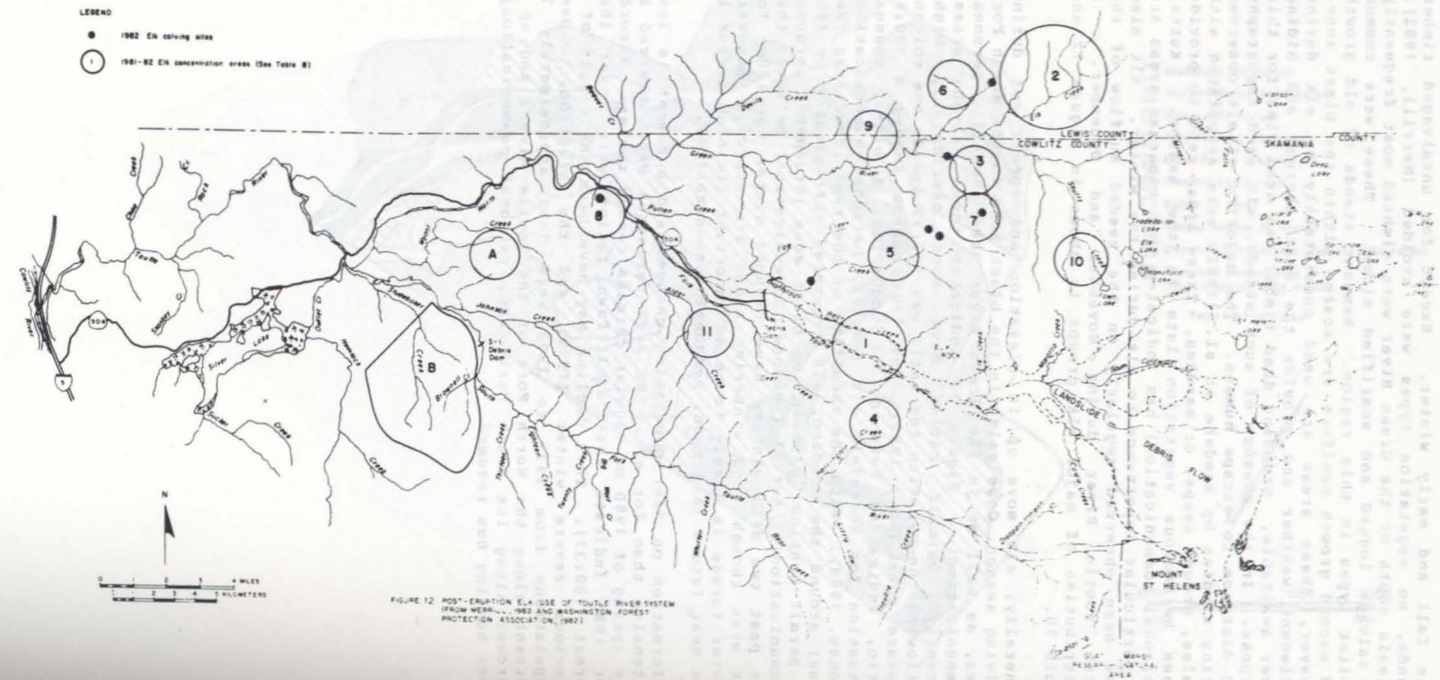


FIGURE 12 POST-ERUPTION ELK USE OF TOUTLE RIVER SYSTEM (FROM MERRILL, 1982 AND WASHINGTON FOREST PROTECTION ASSOCIATION, 1982)

Table 10. A Summary of the Distribution and Estimation of Abundance of the Major Elk Groups on Mount St. Helens in the Study Area. Locations are shown in Figure 7.1/2/

Map Number	Location	Number of Elk
1.	Elk Creek (roads 2600, 2645)	90-100
2.	Hoffstadt Creek (roads 3100, 3200)	55-60
3.	Spotted Buck (roads 3000 and 3060)	60-70
4.	Roads 2570, 2574, 2575 and 2571	50-60
5.	Road 2700	40
6.	Mudflow - North Toutle	6
7.	Spirit Lake Highway	30-45
8.	Road 2501 above Camp Baker	10-15
9.	Roads 1110/1113	30-45
10.	Road 2520	0
A.	Wyant Creek T10N R1E Sections 34 and 35.	
B.	T10N R1E Sections 2-5, 8-11	

1/ From: Merrill, 1982.

2/ From: Washington Forest Protection Association, 1982

Cougar and black bear have been sighted on monthly censuses along the Green River by Weyerhaeuser Company personnel (Anderson, personal communication). Hunting seasons for these species also resumed in 1982.

With only a few exceptions, furbearer and other mammal species found in the area before the eruption have again been sighted (Anderson, personal communication). Twenty-six mammalian species have been observed along a wildlife census route traveled by Weyerhaeuser personnel. Rodent populations in

some areas seeded with grass following the eruption are particularly high. Microtus populations in some areas are 300 voles/acre compared with 5 to 10 voles/acre in undisturbed areas (Anderson, personal communication).

Several new lakes were created within the blast zone when mudflows blocked streams (i.e., Coldwater, South Coldwater, and Castle Creeks). These new lakes, in addition to existing lakes and streams, provide habitat for numerous species of waterfowl and aquatic birds. Canada geese, mallard, wigeon, sandhill crane, dipper, great blue heron, sandpiper and gulls have been observed in censuses conducted along and south of the Green River (Anderson, personal communication).

Ruffed and blue grouse have again been sighted along the Green River (Anderson, personal communication).

A variety of raptors including Cooper's, marsh, red-tailed, rough-legged and sharp-shinned hawks; northern harrier; American kestrel; merlin; and osprey are again using the Green River drainage (Anderson, personal communication). Golden and bald eagle have also been sighted. It is unknown whether spotted owls are continuing to use remaining old growth timber within the blast affected area.

Bird use in the blast affected area is continuing to increase and 107 species have been observed on Weyerhaeuser wildlife censuses. Species noted are comparable to those presently seen in the unaffected areas. Willow flycatcher, western bluebird, loggerhead, shrike, and yellow warbler have been sighted in the area (Anderson, personal communication). Snags which resulted from the blast are being used by a variety of bird species, including mountain bluebird, pileated woodpecker, downy and hairy woodpeckers, and a variety of other cavity nesters.

Future Without the Project

Recovery and revegetation within the blast area will vary according to pre-eruptive site conditions, the severity of the impact received, and man's activities (i.e., actions authorized by P.L. 98-63). Successional patterns can only be estimated by using current plant distributions in the area, past succession of other volcanically disturbed areas, and general information about forest succession. It is assumed for the purpose of this study that a major volcanic eruption will not recur in the near future (although in actuality smaller additional eruptions have occurred and are likely to

continue). The Forest Service (1981) has outlined a possible scenario for revegetation in blast and mudflow affected areas.

In areas with blowdown and standing dead timber and areas with considerable ashfall, residual species are contributing most heavily to early revegetation. Although above ground parts were killed, shoots from unharmed below-ground parts have quickly appeared. Fireweed is common in areas which were clearcut prior to the blast. This species will probably remain dominant for 4 to 5 years or longer. Although some seeds have sprouted in the blast area this past year, at other volcanic sites reproduction from seed did not become significant for as long as 35 years.

Following a forb-dominated period, a shrub domination will probably occur which could last from 10 to 25 years. Huckleberry and vine maple are expected to comprise a significant proportion of the vegetative cover. Riparian areas will probably contain devil's club and, depending on elevation, Sitka alder or red alder. In many areas dense alder thickets already occur. Erosion in some riparian areas could be severe.

Although conifers have invaded the blast area, they will probably not become conspicuous for 15 to 25 years. Conifer stands may develop in 40 to 50 years. Stable forests can be expected in 50 to 150 years.

In areas of mudflows and pyroclastic flows, revegetation will probably occur as small "islands" in areas which have protection from the elements. Vegetation will then radiate out from these sites. Fireweed and lupine will probably be the early pioneer species. Some areas may remain barren. At other volcanic sites some areas have remained barren for as long as 50 years.

A shrub-dominated stage could occur in 15 to 25 years; alders will probably be the early dominants. Under ideal conditions, lodgepole pine will begin to replace shrubs in 20 years and good stands may develop within 50 years. Douglas-fir and western hemlock will also move in relatively early, but will not be as important as lodgepole pine. Silver fir and subalpine fir could form stands, at higher elevations, within 50 years. Stable forests may develop within 200 years but could take considerably longer at some sites.

As revegetation occurs, wildlife populations are expected to gradually increase to pre-eruption levels. Elk are continuing

to use remaining wintering range along the North Fork and Green Rivers and will probably utilize these areas more as riparian vegetation recovers. Species such as spotted owl and goshawk, which are dependent on old growth habitat, will require longer time periods to recover. The mountain bluebird and pileated, three-toed and black-backed woodpeckers may increase in response to newly-created snag habitat located in blast fringe zones.

The future of wetland areas is uncertain. Even if undisturbed by man, riparian and wetland areas are not stable along the Toutle River. As lateral migration occurs in main channels reworking flood plain deposits, vegetated marsh could be again changed into a series of channels. Although the channel aggradation will continue in the near future, the amount of sediment supplied to the stream will eventually decrease causing channel incision throughout the river system. This should not significantly affect wetlands fed by tributary surface flow, but it could decrease flooding frequency and lower the local groundwater base level, thereby reducing wetland water supplies. These changes are likely to occur first in the North Fork of the Toutle valley, then in the main valley (Meyer, personal communication).

Future With the Project

No Action

The "No Action" alternative would result in work authorized by PL 98-63 being continued on the lower Toutle River. Impacts on wildlife resources would be as described under Without the Project.

No Action With Interim Measures (PL 98-63)

With this alternative, recovery of wildlife habitat in the upper portion of the basin would proceed through natural succession to conditions approximating pre-eruption habitat. However, habitat in the lower portion of the Toutle River Basin (as well as the Cowlitz and Columbia Rivers) would be adversely affected by work authorized in PL 98-63. Specifically, the CE would continue to maintain flood control measures along the Toutle and Cowlitz Rivers and maintain the Columbia River Navigation Channel. To provide the flood protection, increased dredging would be required in the river, and the LT-1 and LT-3 sites would be increased in size. This would result in an additional 5,000 to 6,000 acres adjacent to the lower Toutle River being covered with dredge material. As

a result, additional wildlife habitat not previously impacted by the eruption or emergency actions, would be adversely impacted. Additional wildlife habitat would also be lost along the Cowlitz and Columbia Rivers because of increased disposal needs generated by this alternative.

Multiple Retention Structures (MRS)

Construction of two or more retention structures would have a major impact on wildlife resources. Each structure would have similar impacts and substantially increase the total acreage of wildlife habitat covered by the deposition of sediment. This would occur on existing and developing wetlands and uplands along the entire length of the Toutle River. This alternative, by its spatial configuration, would impact wildlife habitat to a greater extent than all other alternatives.

Single Retention Structure (SRS) With Sediment Stabilization Basins

Impacts of this alternative would vary with the location of the structure (i.e. LT-3, Kid Valley, or Green River). The Green River site was most severely impacted by the eruption and its development would have the least impact on wildlife resources.

Placement of the SRS at the Green River site would result in approximately 3,600 acres being covered by sediment during the life of the project. Barren conditions similar to those behind the existing N-1 structure are expected. The SRS would reduce sediment input to downstream areas and hasten stabilization of the stream channel. This would allow riparian, wetland, and upland areas of high wildlife value to develop within the Toutle River flood plain. However, long-term effects may be detrimental because of the reduction in downstream movement of gravel, sand, etc. needed to maintain the sediment budget of the Toutle River.

Use of interim measures to control sediment input to the Columbia and Cowlitz Rivers, specifically sediment stabilization basins LT-1 and LT-3, would also adversely impact wildlife habitat. A total of 1,533 acres; 422 at LT-1 and 1,111 at LT-3, would be covered by dredge disposal. These areas would remain barren throughout the disposal period and as long as 10-25 years thereafter unless revegetation actions are implemented following disposal activities.

A detailed analysis of the Green River site was conducted to determine wildlife values, project impacts, and mitigation requirements. This was done by using the Habitat Evaluation Procedures (HEP) developed by the Fish and Wildlife Service. A description of procedures, methodologies, and findings is presented in Appendix B.

Construction of the Green River SRS is expected to result in a reduction of habitat available for Roosevelt elk, small predators (e.g. shorttail weasel, bobcat), small mammals (e.g. Townsend chipmunk) and amphibians (e.g. Pacific giant salamander). Other species are expected to show some increase in available habitat (e.g. common snipe, mallard, song sparrow, black-tailed deer, and beaver). Habitat for species such as red-tailed hawk, golden-crowned kinglet, and ruffed grouse is not expected to change significantly over the next 50 years.

Although not evaluated in the HEP analysis, stabilization of the Toutle River downstream from the retention structure would speed recovery of riparian vegetation. This is likely to result in improved wildlife habitat conditions during the life of the project.

THREATENED AND ENDANGERED SPECIES

In accordance with Section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531, et seq.), all federal agencies are required to assure that their actions have taken into consideration impacts to federally listed or proposed threatened or endangered species for all federally funded, constructed, permitted, or licensed projects within their jurisdiction.

Through coordination with our Endangered Species staff, we have determined that listed species may be present within the project area. You may consider the list provided in Appendix D as a response pursuant to Section 7(c) and you may begin a biological assessment if you determine this action to be a "construction project."

If you have any questions regarding Endangered Species or your responsibilities under the Act, please contact:

Mr. Jim Bottorff
Endangered Species Team Leader
U. S. Fish and Wildlife Service
2625 Parkmont Lane SW
Olympia, WA 98502
(206) 753-9444
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COWLITZ RIVER

The Cowlitz River is the lowest major tributary to the Columbia River. It drains the west slopes of the Cascade Mountains, specifically the north and west sides of Mount St. Helens, the southeast side of Mt. Rainier, and the northwest portion of Mt. Adams. The drainage basin encompasses 2,480 square miles. Two hydroelectric dams control about half the basin and affect downstream flows. The Toutle River is the major tributary below the dams.

The Cowlitz River in the project area is a low gradient stream. It has a channel slope of 4.5 feet per mile above RM 14.5 and 1.2 feet per mile below RM 14.5. For the most part, it flows through a flood plain 1/2 to 1 mile wide. It is confined by hills to the east and west. Below RM 5, the flood plain extends to the west for 4 to 5 miles, encompassing all of the town of Longview.

The cities of Longview and Kelso and their industrial areas facing each other across the Cowlitz River are protected by levees, as is the city of Castle Rock. Lexington, an unincorporated area, is partially protected by levees. The rest of the flood plain area, from RM 10 to 16, and 17.5 to 27.5 is not protected. This is a rural area of pastureland, small farms, rural homes, and riparian forested areas. There were several commercial sand and gravel operations along the river before the eruption.

FISH

Pre-eruption

Significant numbers of fall chinook salmon spawned in the lower Cowlitz River between Kelso and the mouth of the Toutle River. An average of 183 (range 86 to 354) redds (spawning nests) were observed in this section of river during annual aerial surveys conducted by WDF personnel between 1973 and 1979 (Mohoric, personal communication). Fall chinook produced in this river reach contributed 7,320 fish worth $360,400 annually to sport and commercial fisheries.

The lower Cowlitz River was a migration pathway and rearing area for anadromous salmon and trout produced in the Toutle and upper Cowlitz River Systems. It also hosted a large spawning run of smelt (eulachon).

Juvenile or adult anadromous salmonids occurred in the lower Cowlitz River throughout the year. Downstream migrations of juvenile fish generally took place from late winter to early summer. Upstream migrations of adult fish peaked at different times of the year in the lower Cowlitz, depending on the species, race, or stock of fish. However, each run of fish lasted several months so that they overlapped and adult salmonids were present in the river at all times. Figure 5 shows the general times that salmonids were present in the lower Cowlitz River.

Concentrated sport fisheries for fall and spring chinook salmon occurred at the mouth of the Cowlitz River, at Riverside Park in Lexington (RM 8.5), and at the Cowlitz-Toutle River confluence. Angling for steelhead and searun cutthroat trout occurred throughout the lower Cowlitz River.

Smelt usually entered the Cowlitz River between January and March whenever suitable water temperatures (about 40° F) occurred. Spawning occurred from near Kelso to the mouth of the Toutle River. After fertilization, smelt eggs adhered to substrates that ranged between sand and pea gravel in size. Eggs hatched after 2 weeks of incubation and larval smelt drifted downstream to begin their seaward migration.

Important commercial and personal use smelt fisheries took place in the lower Cowlitz River. Most fish were caught by dipnetting from boats or riverbanks. Average commercial smelt harvest for 1976 to 1980 for the lower Columbia River was about 2 million pounds (Mohoric, personal communication). Investigations by the Washington Department of Fisheries for 1978 showed that the sport catch equalled the commercial harvest. Much of the commercial and most of the sport catch occurred in the Cowlitz River.

Eruption

The mudflows from the eruption impacted the Cowlitz River Valley from the mouth upstream to about RM 25 (about 5 miles above the mouth of the Toutle). An estimated 40 mcy of material were deposited in the Cowlitz River and the channel infilled from 5 to 15 feet. In addition, a layer of mud up to several feet thick was deposited over the entire flood plain. Tributaries entering the Cowlitz were blocked or partially filled. Several water intake structures were also filled or blocked (USACE, 1981). Fish in the river at the time were presumed killed, either from suffocation due to high turbidities or high water temperatures.

Post-eruption

Stream habitat in the lower Cowlitz River remains in a very unstable condition. The Toutle River continues to carry large amounts of sediment into the Cowlitz. The heavier sand and gravel is deposited in the Castle Rock area. This material must be dredged out to provide the 100-year flood protection required by PL 98-63.

Since 1982 the lower 10 miles of the Cowlitz has reached an equilibrium with an accumulation of only 1 mcy. The sediment movement is very dynamic with winter scour and summer infill. On an annual basis, most of the material entering the Cowlitz from the Toutle is now passed on into the Columbia River.

The Cowlitz is very unstable laterally. Bank erosion is creating serious problems in some areas, such as Horseshoe Bend. The river is tending to braid, and bars and islands have formed in many places.

The stream gradient above RM 14.5 has increased to 5.1 feet per mile. The slope below RM 14.5 has stabilized at the pre-eruption gradient of 1.2 feet per mile.

Lower Cowlitz River tributaries that were blocked by mudflows have been cleared of debris and mud by the Soil Conservation Service. About 6.5 miles of stream channels have been dredged to prevent flooding and improve fish passage (Shavlik in Martin, 1982). Banks along these streams were seeded with grass and planted with woody vegetation during 1981 and 1982.

Spawning runs of smelt returned to the Cowlitz River in 1981, 1982, 1983, and 1984. The commercial harvest of smelt reported for the Columbia River tributaries was about 1.4 million pounds for 1981, 1.6 million pounds for 1982, and 2.6 million pounds in 1983. Much of this harvest was taken from the Cowlitz River. 1984 was a poor year with about 350,000 pounds taken from the entire Columbia River System. The success of smelt spawning since the eruption is unknown because of high turbidities and changing riverbed conditions. Smelt return to spawn at age 3 or 4. Effects of high turbidities on spawning success should have appeared in 1984. The smelt return to the Cowlitz in 1984 was low, with no return to the Kalama, Lewis, and Sandy Rivers. The global weather phenomenon known as El Nino could also have had an effect on returning smelt.

Future Without the Project

Large amounts of sediment would enter the Cowlitz River from the Toutle. The Corps sediment study predicts total yields of sediment to the Cowlitz River of approximately 34 mcy in 1985 with sand size material at 17 mcy. By 2013 sand yield to the Columbia would have dropped to about 4 mcy per year and remain at that level for at least 25 years. A total of 78 mcy of sediment would accumulate in the Cowlitz River in the first 20 years. Coarse sands and gravels would continue to deposit above Horseshoe Bend until the inflow drops to 5 mcy per year (about 20 years). At that time the river would begin to scour. As bed levels in the channel rise, more sediment would be deposited in the flood plain. The river would become very unstable as the bed fills, and could develop new channels during high flows. Braiding and lateral instability would continue until the deposited material has been scoured out. This process would continue for over 30 years. The bed of the Cowlitz would then begin to stabilize vertically and horizontally.

Gravel areas below the Toutle would eventually support successful spawning for fall chinook salmon, but this would not occur for many years. Turbidities in the Cowlitz would remain high. The Cowlitz would act mainly as a migratory path for salmonids. It is not possible to predict at this time whether the high turbidities and unstable substrate would have an adverse effect on smelt spawning, although it is expected that they would. Dredging in the Castle Rock area is expected to continue as long as economical disposal sites are available.

Future With the Project

Construction of a retention structure on the Toutle would halt sediment flow from the debris avalanche almost immediately. The Corps sediment study predicts that excess materials in the Toutle/Cowlitz system would erode out naturally in 3 years. Dredging in the Castle Rock area would continue while the structure was being built. Dredging could be discontinued as soon as the river was able to maintain 100-year flood protection by itself.

Gravels immediately below the mouth of the Toutle should support some limited spawning by fall chinook within 5 years after the dam is completed provided that sufficient gravels remain or are augmented as necessary. Turbidities would be reduced, but would not return to pre-eruption levels since the dam is not designed to retain finer sediments.

Stabilization of the river bed would allow riparian vegetation to reestablish. This would provide water quality benefits in the form of reduced turbidity and temperature moderation, as well as a food source for fish and benthic organisms. Shallow water rearing areas for juvenile salmonids would also reestablish. Sport fishery opportunities would increase with improved river conditions.

WILDLIFE

Pre-eruption

Habitat

Terrestrial habitat in the Cowlitz River valley was a mixture of pasturage/agricultural and riparian/flood plain. Habitat types were similar to those on the Columbia River. Additional tree species were present in the Cowlitz Valley, including big leaf maple, red alder, and coniferous species such as Douglas-fir, western hemlock, and western red cedar. These species were usually found at slightly higher elevations, out of the wetlands. Willow species may have differed from those along the Columbia River. Forested habitats were much smaller in size than on the Columbia, and there was more open space.

Wildlife

Human presence and related urban/industrial development limited wildlife species in the Cowlitz valley. Small numbers of black-tailed deer were present and black bear occasionally wandered down from the surrounding hills. Aquatic furbearers, although present, were of minor importance. Species present included beaver, muskrat, mink, nutria, weasel, and river otter. Small mammals, including rodents, were plentiful. Included were coyote, raccoon, opossum, striped skunk, eastern cottontail rabbit, shrews, mice, voles, and moles.

The Cowlitz River valley had little waterfowl value. Small numbers of Canada geese, mallard, and wood duck may have nested in appropriate habitats. Use was higher during spring and fall migration and overwintering, but low compared to other sections of the Columbia River.

Ring-necked pheasant, California quail, ruffed grouse, band-tailed pigeon, and mourning dove were present in small numbers and offered limited hunting opportunities.

Raptors were numerous because of the excellent food supply (small rodents). Most common species were the red-tailed hawk, northern harrier, and American kestrel. Several species of owls were also present, and osprey were occasionally seen at the mouth of the Toutle. Numerous other bird species were also present. The most common included great blue heron, gulls, northern flicker, swallows, American crow, black-capped chickadee, Bewick's wren, American robin, European starling, song sparrow, blackbirds, and American goldfinch.

Eruption

Extensive areas of the Cowlitz River valley flood plain were covered by the mud flow. While most trees remained standing, the understory shrubs, forbs, grasses, and lower limbs of trees along the river bank were washed or abraded away. Back channels, sloughs, low spots, and small drainages were filled in and 1 to several feet of mud, ash, and debris were deposited on most of the unprotected valley floor. Forbs and grasses in the pasture and agricultural areas were also buried. Larger mammals may have been able to escape, although some cattle did not. Smaller mammals, especially underground burrowers, probably suffered almost total extinction, either from burying, suffocation, or heat. Birds probably had little direct loss because of the eruption, except for ground and shrub nesting birds whose nests were destroyed.

Post-eruption

Much of the vegetation covered by the mud flow was either killed outright at the time of the flow or died later. Willows and cottonwood, which are normally exposed to siltation annually, had a higher chance of survival than more upland species such as maple, alder, and conifers. It was also thought that the thinner barked trees (maple and alder) and young willow, cottonwood and conifers could have been killed or stressed by the high temperatures associated with the mud flow.

Shrubs associated with willows and cottonwood may have survived mud flow deposition, but many were abraded or washed away. Grass and forb survival varied with the amount of deposition.

Actual recovery from initial burying by the mud flow is mostly speculative, as much of the flood plain impacted by the mud flow was later used for dredge spoil disposal.

Work was started almost immediately to restore flood control capacity to the Cowlitz River channel. When work was phased out in the spring and summer of 1981, a total of 20 mcy had been removed from the lower Cowlitz (RM 0 to 9) and 56 mcy from the upper Cowlitz (RM 9 to 27.5). This provided a channel capable of handling 50,000 cfs. Approximately 7 miles of levees were built or improved to provide 500-year flood protection.

Dredging occurred again the winter of 1983-84 to restore 100-year flood protection; 7.8 mcy was removed from RM 13.25 to 20. The material was placed on existing disposal areas.

Disposal sites for dredged material are shown on Figure 13. Almost all of these sites have been filled; therefore, future dredge disposal capacity is extremely limited.

The State of Washington (Department of Transportation) has acquired some of the disposal areas in the vicinity of Castle Rock. These lands will be transferred to the Department of Natural Resources for management. Some of the dredging contractors have also bought parcels of land to be used for disposal. However, after the 1983-1984 winter dredging season, economically acceptable disposal sites have become even more limited.

There has been little or no recovery of wildlife habitat. Wooded areas were cleared before being used for disposal. There are a few remaining clumps of trees around farms and houses and the few places not used for disposal. The disposal sites have been seeded with grasses and legumes, but require continuous application of fertilizers containing nitrogen to survive. This has not been done.

Few mammals are now present in the area. Species remaining are those which can adapt to human activities, as most of the cover and food are around human habitations. It is not expected that shrews, moles, voles, and mice are able to survive in areas of deep deposition or spoil areas. Loss of these animals also means decreases in predator species such as coyotes and raptors. Birds inhabiting the surrounding hills may still find some food in the valley, but nesting sites and cover are extremely limited for many species.

Future Without the Project

The 100-year flood protection would be maintained under authorization of PL 98-63. Dredging in the Castle Rock area,

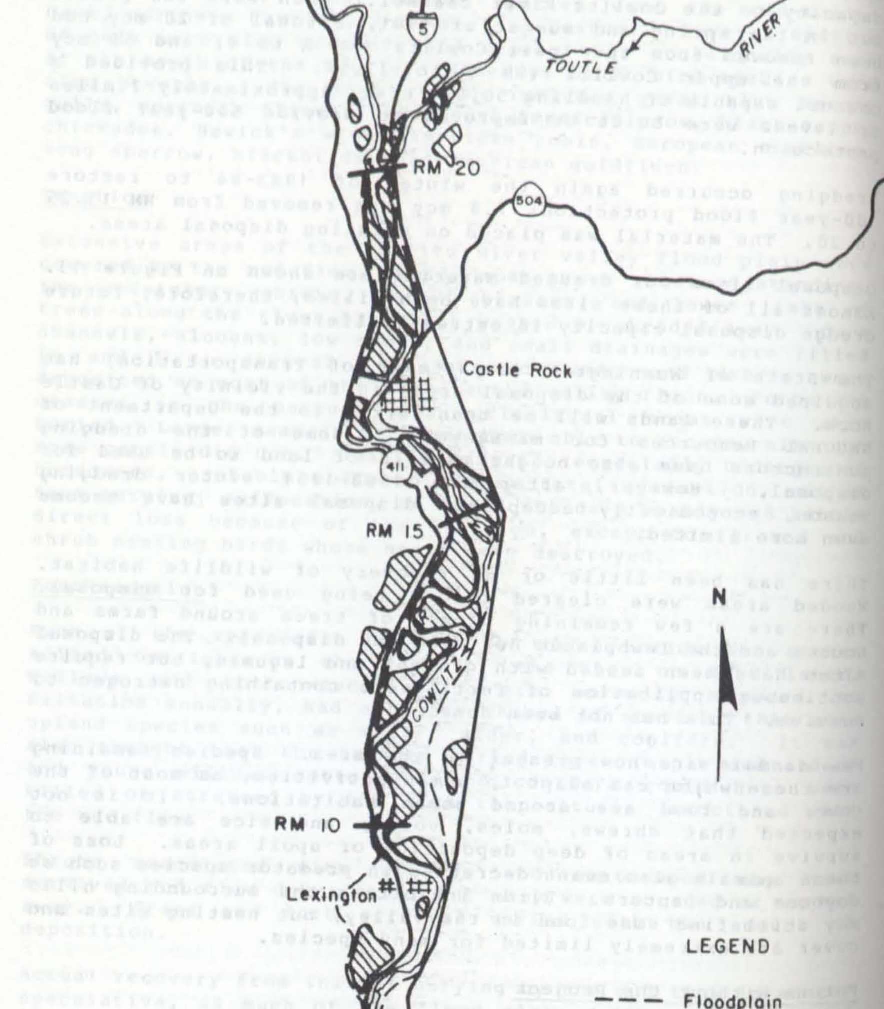

FIGURE 13 COWLITZ RIVER

as well as in the Toutle, would continue until economically feasible disposal sites are exhausted. After that the levees would have to be raised again. This would be a major project, as the entire levee system would have to be rebuilt with a wider base.

A very large storm or eruptive event, or 2 large storms back to back, could fill the channel in the vicinity of Castle Rock and Lexington and overtop the levees. Wildlife habitat in more urban areas, which had not previously been affected, would be impacted by flooding.

The river would remain extremely unstable, both laterally and vertically, for over 50 years. The river would probably break through at Horseshoe Bend (RM 13-15). Recovery of riparian habitat along the river would be slow and would not occur until the riverbed had stabilized. Disposal sites, once they had been filled to capacity, would gradually revegetate. Initial plant species would probably be lupine, grasses and scotch broom. Cottonwood and alder could be expected to become established within 10 years.

Future With the Project

Dredging under PL 98-63 would continue until the Cowlitz can maintain 100-year flood protection with natural flushing. This should occur about 5 years after the start of the project. Disposal sites in the vicinity of Castle Rock can be seeded to establish permanent revegetation at that time. The bed of the Cowlitz River should begin to stabilize about the same time, starting at the upper end. Emergent vegetation should also start to reestablish in the more stable areas. Riparian vegetation, such as cottonwood, willow, and alder, would also start to reestablish.

Small rodent populations should be noticeable on disposal sites 10 years after the start of the project. Raptor use would increase accordingly. Big game species would not return to pre-eruption densities until cover species had attained sufficient growth. This would probably be near the end of the project life. The numbers of avian species present which require this habitat type would also remain low.

THREATENED AND ENDANGERED SPECIES

Bald eagles may be sighted infrequently. There are no known endangered or threatened plants or candidate species in the Cowlitz River valley.

COLUMBIA RIVER

The Columbia River is the second largest river in the United States. Its flows are regulated extensively by dams upstream on the mainstem and on tributaries. Average annual flows range between 150,000 cfs and 600,000 cfs. Flows in the Columbia west of the Cascades are directly affected by annual precipitation, particularly winter storm events. The lower Columbia is also subject to diurnal tidal effects. The drainage area above Longview is 256,700 square miles.

The climate in the project area is maritime, characterized by mild, wet winters and cool, dry summers. Average annual precipitation at Longview is 45 inches. Upper soils are of recent alluvium in origin, overlying older alluvium and glacial deposits which, in turn, overlie Columbia River basalt and other formations.

A detailed discussion of fish and wildlife in the Columbia River Estuary is contained in a recent Coordination Act Report on navigation channel deepening at the mouth of the Columbia River (Ellifrit, 1983). That portion of the Columbia River between RM 56 and 73 is discussed in more detail in the present report. This section of the Columbia River lies in the Lower Columbia subregion of the Puget Sound Trough. The Cowlitz River enters the Columbia where it bends to the west at RM 68 (Figure 1). Major islands remaining in this section of the river are Cottonwood, Howard, Lord, Walker, and Fisher. Cottonwood and Howard Islands and Lord and Walker Islands have been connected by deposition of navigation channel maintenance dredging material, and Fisher Island is now contiguous with the smaller Hump Island. Shorelines are relatively undeveloped. The city of Longview, Washington has an extensive industrial waterfront while Rainier, Oregon, across the river, is smaller and less developed. The remaining riverfront is low intensity agriculture (mostly grazing), either diked or undiked, or is in open space or is forested wetlands or dredge spoil. Trojan nuclear plant, on the Oregon shore, is at the upstream end of the project area.

FISH

Pre-eruption

The Columbia River and its tributaries support highly valuable runs of anadromous fish, as well as resident fish. In the project area, the Columbia serves as a migratory path for

adult and juvenile coho, chum, sockeye, and spring, summer, and fall chinook salmon; winter and summer steelhead trout; searun cutthroat trout; and shad (Figure 5). These fish are very important to both the commercial and sport fishery. Adult salmon and steelhead are normally found in deeper waters. Shallow waters such as side channels, sloughs, and backwaters are particularly important for food and cover for some juvenile salmonid species. Carrolls Channel is an important migratory path for juveniles.

Adult and juvenile sturgeon are also present in the area. Adults are more often found in deeper areas such as off Trojan Nuclear Plant. Juveniles tend to feed in shallow water.

Warmwater fish spawn, rear, and feed in backwater areas, although some are found in the main river. Game species include: yellow perch, black and white crappie, bluegill, warmouth, largemouth bass, brown and yellow bullheads, and channel catfish. Nongame species include: three-spined stickleback, carp, peamouth, northern squawfish, sand roller, chiselmouth, prickly sculpin, and coarse-scale sucker (Fies, 1971). Juvenile starry flounder, a marine fish, are also present in the Columbia in the project area.

The area has a fairly intensive sport fishery. Table 11 shows trips and catch for anadromous fish for 1979-1982. Important bank fisheries in the Longview/Rainier area are Prescott Beach, several shoreline areas upstream from Rainier, downstream from the Lewis and Clark Bridge on the Oregon shore, and Willow Grove Beach. Heavily used boat fishing areas for salmon are off Prescott Beach above Rainier, the mouth of the Cowlitz, below the bridge, the channel south of Lord Island, and the Washington shore along and below Willow Grove Island.

Commercial salmon gill net drifts are located in Carrolls Channel, off Cottonwood Island, above and below the Lewis and Clark Bridge, in the channel on the south side of Lord and Walker Islands, and on both sides of the main channel along Fisher Island and Willow Grove Island. An important sturgeon fishing hole is near Coffin Rock.

Angling pressure on warmwater gamefish is light to moderate. The more popular spots include Prescott Slough, Dibblee Point, Rinearson Slough, and Coal Creek Slough.

Table 11. Sport Fishery, Columbia River, River Mile 46-72. (From King, 1980, 1981, and 1982)

	1979	1980	1981	1982
Oregon Bank				
Salmon Trips	14,754	12,196	15,123	20,728
Catch				
Spring Chinook	118	299	503	1,583
Fall Chinook	751	179	239	384
Coho	46	26	0	267
Steelhead	256	588	133	2,249
Cutthroat	273	310	150	786
Sturgeon Trips	885	766	524	822
Catch	0	56	0	30
Shad Trips	3	0	0	0
Catch	0	0	0	0
Oregon Boat				
Salmon Trips	1,585	619	2,025	1,375
Catch				
Spring Chinook	12	16	167	113
Fall Chinook	67	0	6	1
Coho	29	0	0	1
Steelhead	0	0	0	0
Cutthroat	0	12	78	107
Sturgeon Trips	298	824	530	321
Catch	81	56	18	12
Washington Bank				
Salmon Trips	13,599	5,829	10,051	10,795
Catch				
Spring Chinook	58	64	49	
Fall Chinook	58	12	83	
Coho	1,069	187	271	67
Steelhead	711		732	865
Cutthroat	1,725	1,730	3,897	2,473
Sturgeon Trips	4,651	4,283	5,297	5,713
Catch	331	420	1,039	573
Washington Boat				
Salmon Trips	4,229	436	1,198	1,856
Catch				
Spring Chinook	5	6	0	0
Fall Chinook	244	0	26	17
Coho	981	0	0	408
Steelhead	0	0	0	0
Cutthroat	154	14	616	554
Sturgeon Trips	2,369	1,459	2,837	2,959
Catch	953	273	211	464

Eruption

The first mud and water flow from the eruption reached the Columbia on the afternoon of May 18. This flow was hot, and carried a high sediment load and tons of debris (both uprooted trees and cut timber from log decks). A second mud and water flow, two to three times the discharge of the first flow, occurred the night of the 18th and early the 19th. Between midnight and 5:00 a.m. the 40-foot navigation channel had filled in to 14 feet. Approximately 50 mcy of sand size and larger material was deposited in the Columbia, 14 million of it in the navigation channel. Deposition occurred between RM 63 and 72. Although there was an ebb tide at the time, almost all of the material was deposited upriver from RM 67.5 with a fairly uniform 15' depth across the Columbia at the mouth of the Cowlitz (USACE, 1981). The sturgeon hole at Coffin Rock was filled in, and an unknown quantity of material was also deposited in Carrolls Channel.

Additionally, millions of cubic yards of finer material was carried downstream in suspension with some being deposited in slower waters in the Columbia River estuary. Approximately 7 to 8 centimeters of fine sediment was deposited in some channel areas in Cathlamet Bay (Holton, personal communication). Although much of the trees, logs, and debris was carried to the ocean, some was stranded on the shoreline along with quantities of pumice and even heavier rocks.

Post-eruption

Dredging to reopen the navigation channel started immediately. The Corps of Engineers entire west coast hopper dredge fleet (three vessels) was at work within 3 days. The material was deposited adjacent to the channel and much was later rehandled by pipeline dredges.

Two inwater fill sites were created downstream. The Rainier fill, on the Oregon shore, had a capacity of 6 mcy. In addition to acting as an immediate disposal site, it fulfilled a long-standing Corps of Engineers desire to narrow the river at this point to make the channel self scouring.

Weyerhaeuser Company, on the Washington shore below the bridge, had been developing a plan to fill its entire waterfront and log storage area, but had not started the permit or Environmental Impact Statement process. A portion of this area was diked and 1.5 mcy of material placed in it by the Corps. Weyerhaeuser has continued to use this site to

dispose of material dredged to maintain adequate water depths along its waterfront.

The Corps has removed 2 to 5 mcy by overdredging the channel to 45 to 50 feet in the Longview area. This has provided some leeway in case of a storm event. Approximately 3 mcy has been dredged from the sump at the mouth of the Cowlitz in each of the past 3 years.

Temperatures and turbidities in the Columbia River dropped fairly rapidly, due to the dilution effect. A turbidity measurement at RM 47 on May 20th was 2,880 JTU's and had dropped to 27 JTU's by June 6. Background turbidity is normally 5 to 10 JTU's at this time of year.

The only adult anadromous fish in the Columbia River at the time of the eruption were spring chinook and shad. The eruption, as manifested by high turbidities and debris, did not appear to affect the migration of fish going above the Cowlitz. No effect was noticed on adult fish passage over Bonneville Dam. There was, however, a noticeable effect on downstream migrants. Although the peak of the out-migration had passed, there was a significant drop in juveniles captured at a permanent sampling site at RM 47 (Jones Beach). This was particularly true with fall chinook. Catches remained low for about 2 weeks while turbidities were still quite high. Catches later returned to normal (NMFS, 1980).

There were no known fish kills in the Columbia River due to suffocation, gill abrasion, or heat.

Researchers noted a number of effects in the Columbia River Estuary. The fine material which settled in the estuary affected benthic invertebrates and demersal fish.

Benthic sampling in some areas of the estuary revealed low numbers of Corophium salmonis, a brackish/freshwater amphipod, following the eruption. In other locations this species was present in normal numbers, but was buried under ash layers. It is assumed that this amphipod was adversely affected by the high turbidities, but the exact mechanism is not known. Almost no C. salmonis was found in stomachs of salmonid and non-salmonid fish collected in June 1980, and apparently no other food item was found to make up this loss. Comparison sampling a year later revealed that C. salmonis numbers had recovered or even increased in numbers over pre-eruption figures in benthic sampling. Starry flounder, a demersal fish, was feeding on C. salmonis at pre-eruption rates.

juvenile salmonids, however, were not. The reason for this is not known (Emmett, 1982).

High turbidities due to resuspension of the fine material continued in the estuary for several weeks. Demersal species such as Dungeness crab and flounder were caught in a purse seine, which is used to catch pelagic species. Sight feeding fish were probably most affected, due to the low visibility, but recovered as soon as turbidities dropped. Demersal fish disappeared immediately after the eruption, but later returned in normal numbers (Durkin, 1982).

Sturgeon also were affected by the eruption. Test fishing in June and July 1980, indicated low numbers of sturgeon in the Columbia below the Cowlitz River. Many Columbia River tagged sturgeon were recovered outside the system as far south as Yaquina Bay in Oregon, and to the north in Willapa Bay, Grays Harbor, Neah Bay, and inner Puget Sound. This indicates that resident fish were forced out of the river by high turbidities (Stockley, 1982). Test fishing subsequently has indicated a return to pre-eruption numbers of both adults and juveniles.

The Corps sediment study for the comprehensive plan predicted that large quantities of sand and fines would enter the Columbia, with concurrent dredging requirements. An estimated 9.5 mcy of sand and 16 mcy of fines were delivered to the Columbia from the Cowlitz in water year 1983. However, an increase in dredging or deposition in the Columbia does not seem to have materialized. Navigation channel dredging amounts downriver have not increased. A study of deposition in the river showed an initial deposition of bedload material occurring outside the navigation channel. This material has since disappeared (Hartman, 1984).

Apparently the interim dredging measures have reduced the sediment inflow from the Cowlitz. However, a probable 10-year storm event in December 1982 deposited 2.4 mcy of sand in the Columbia at the mouth of the Cowlitz. As a result, 1.5 mcy had to be dredged from the navigation channel to restore authorized depths. Additional events of this kind are likely to occur.

Industries along the Longview waterfront have experienced greatly increased deposition of fines. Estimated dredging requirements are 0.5 mcy annually.

There is no information available on the fate of fines in the estuary.

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Future Without the Project

With no interim actions (PL 98-63 and Cowlitz sump), approximately 351 mcy of sand and 277 mcy of fines are predicted to enter the Columbia in the next 50 years. One fourth of the sand and almost half of the fines will enter in the next 10 years. The majority of the sand (70 percent) will enter from the Cowlitz during the winter (October to March). The Cowlitz flows are high during this period and carry a heavy sediment load because of winter rains. In comparison, the Columbia flows, which control deposition in the Columbia, are relatively low. The Columbia has a net deposition between June and February and net scour during the spring freshet, March to May. Under winter flow conditions, most of the material could be deposited at or near the mouth of the Cowlitz and could block the navigation channel. The spring freshet flows are capable of removing most of this material, but the time of removal is not satisfactory. The remaining 30 percent of sand materials from the Cowlitz could be carried by the Columbia and probably would not require dredging.

It is estimated that approximately 7 mcy will be deposited in the Columbia River in the Longview area in 1985. This will decrease to 2 mcy by 2006 and stay at that rate for at least the next 30 years. Table 12 shows sediment yields to the Columbia and amounts deposited in the Longview area. It is estimated that, with a high sediment load, 40 percent of the material would be deposited in the navigation channel. In the one documented storm event (December 1982), 60 percent of the material was deposited in the channel. Using the conservative figure of 60 percent, dredge amounts were calculated as shown in the table.

It is presumed, however, that interim measures would continue under the no action alternative. With the interim measures, the base condition, 39 mcy would be dredged from the Toutle River and 74 million from the Cowlitz River. It is estimated that 521 mcy of sand and fines would enter the Columbia River. Of this amount, 71 mcy would be deposited in the vicinity of the mouth of the Cowlitz and would have to be dredged from the navigation channel; 450 mcy would move through the Columbia River system. This material would be 2/3 fines and 1/3 sand.

Operation of the Cowlitz sump would probably continue as long as economically feasible disposal sites were available.

Table 12. Sediment yield to the Columbia from the Cowlitz and amounts to be dredged in the Longview area in mcy (from Corps of Engineers data).

	Years							
	1985-89	90-94	95-99	2000-04	05-09	10-14	15-19	20-24
FINES	79	53	37	30	26	18	13	10
SAND	54	41	35	35	32	30	30	30
70% winter flow	37.8	28.7	24.5	24.5	22.4	21	21	21
Deposited Longview	32.5	24	17.5	11.5	10	10	10	10
Dredged (60%) Longview	19.5	14.4	10.5	6.9	6	6	6	6

Sump dredging may not have to continue for more than 15 years.

All of the above calculations are based on the 4 years of flow data collected since the eruption and do not include any major storm events. A 10-year storm event could deposit 3 mcy in the navigation channel. It has been estimated that a 100-year storm would require 5.1 mcy to be dredged from the channel and a large mudflow 6 mcy.

Normal maintenance dredging requirements of 1.1 mcy in this reach are also not included in Table 12. Apparently, no net deposition has occurred in the active channel outside the navigation channel. However, it is possible that seasonal deposition and scour is occurring. Some material would be deposited in back channels, with perhaps one half remaining permanently. When the material reaches the estuary, about RM 37, it may drop out in the shallow areas. Accelerated shoaling of the bays can be expected. A Corps study predicts a total of 202 mcy to be dredged from the estuary portion of the navigation channel (RM 2.0 to 33.7) over the next 30 years. Present dredging in the estuary is 2 mcy annually. It is expected that material dredged from Tongue Point (RM 18) and below will be disposed of in offshore sites.

Entrances to some sloughs and backwater areas along the river could be shoaled in to the extent that they are open only during high flows. These areas are used as feeding, resting, and cover by juvenile salmonids, particularly fall chinook, in their downstream migration, and by resident warmwater fish and juvenile sturgeon. All of these species enter such areas during the spring freshet and could become trapped as the water recedes.

During the past few years, over half of the regular maintenance dredging in the Columbia has been done by hopper dredge with inwater disposal. Continuation of this practice would accelerate shoaling of sloughs and backwaters to the detriment of aquatic resources.

The shallow parts of the estuary, such as Desdemona, Taylor and Upper Sands, and Grays, Cathlamet, Youngs and Baker Bays, would become even shallower. Deposition of both sand size and finer material from either river flow or inwater dredge disposal would have a definite adverse impact on benthic, epibenthic and vegetative production. Benthic populations would probably not be smothered outright, but production would be lowered and present species could be replaced by pioneer species. Shoaling of vegetated areas, as predicted by the Corps, would change the ratio of marsh types. Overall, high marsh would increase and estuarine primary productivity would be lowered, as high marsh contributes less to the system. This would in turn lower productivity of higher trophic levels. Species particularly affected would be juvenile salmonids and marine fish and crabs.

Offshore disposal of material dredged from the navigation channel is expected to have adverse effects on offshore benthic and fish populations. Existing sites would not be adequate for the additional material. At least one more offshore site would have to be located and designated to handle Mount St. Helens material.

<u>Future With the Project</u>

With any of the alternatives considered, sediment flow into the Columbia would be the same for the first 5 years. In year 1, 14 mcy would be removed from the Toutle at LT-1 and LT-3 and 13 mcy in year 2. This would reduce the yield to the Cowlitz to such an extent that the Cowlitz would begin to scour. An estimated 5 mcy would have to be dredged from the Columbia in year 1 and 4 mcy in year 2. The Cowlitz sump would be operated these 2 years, with approximately 3 mcy

removed each year. Based on past experience, no additional dredging should be required in the Columbia River navigation channel. The retention structure should be operational in year 3, cutting off all sand and larger grain size recruitment from the debris avalanche. Erosion of material from the Toutle and Cowlitz would yield a predicted 2 mcy a year for the next 3 years to be dredged from the Columbia River navigation channel. No additional dredging of sand size material is expected for the life of the project except for major storm events and/or mudflows before the project is built and after 1995.

Since the structures are not designed to trap fines, they would still be coming through the system. Turbidities would remain high and fines would be expected to deposit in side channels and backwaters in the river and shallow areas in the estuary. The total amount of fines would probably be somewhat less than predicted for the no action alternative as some material would be deposited in developing wetlands and shallow areas in the Toutle and Cowlitz.

WILDLIFE

Pre-eruption

Habitat

Terrestrial habitat along the Columbia River is characterized as riparian/riverine/bottomland/flood plain and ranges from tidal emergent marshes to open grassy or forested uplands. Riparian habitat types encompass wetland, transitional and upland water regimes.

Following is a discussion of the principal habitat types found in the area.

Riparian Forest (FO). There are 4 major habitat types in the riparian forest.

1. Mature willow. Usually Pacific willow. Can occur in very dense stands, at lower elevations. It is usually seasonally flooded by winter rains and spring freshets.

2. Ash swale. Usually pure stands of ash with little understory at higher elevation than mature willow. These sites may be flooded by spring freshets.

3. Ash/willow/cottonwood. This mixed species habitat has very high diversities and densities of bird and animal species.

4. Mature cottonwood. Usually found at slightly higher elevations than the above types. Pure stands of mature trees are often found on islands where heights may reach over 100 feet. This habitat is seldom flooded.

Common understory shrubs and forbs found in the forested habitats include: red-osier dogwood, red elderberry, snowberry, young willow and cottonwood, blackberries, salmonberry, climbing nightshade, stinging nettle, orange balsam, horsetail, cresses, candyflower, slough sedge, swordfern, and mosses.

Scrub/shrub (SS). This type is comprised mainly of Pacific willow, but Columbia River willow may be present, especially in low, sandy areas. Young cottonwood trees are sometimes present at upper levels.

Freshwater marshes (EM) are both tidal and non-tidal. Tidal marshes are usually in sheltered areas along the edges of the river, channels, sloughs, and backwater areas and are affected by daily tidal changes. Non-tidal wetlands are usually away from the river and may have standing water only during periods of high water or heavy rainfall. Species commonly found in these wetlands include: reed canarygrass, spike rushes, Juncus spp, bulrushes, sedges, skunk cabbage, common silverweed, mudwort, wapato, cattail, cyperus, docks, lilaeopsis, clovers, lowland cudweed, smartweeds, jointgrass, cocklebur, elodea, water plantain, and beggarticks.

Flats (FL) are areas of silty sand or finer materials which are normally exposed only during lower river levels. They are usually unvegetated because of the diurnal tidal changes, which are about 4 feet at Longview. The tides are most noticeable during the relatively low flow period from early August through October, but also have an effect on river levels at mid-range flows. Algae and benthic invertebrates found on flats provide an important food source for birds and fish.

A complex of habitat types has been designated grasses (GR). There are several types involved. One often occurs on dredge spoil areas along the river's edge. In addition to grasses, weed species such as tansy ragwort, thistle, teasel, and goldenrod are also found in this habitat. There is a

gradation depending on length of time since last spoiled upon. Sites which have not been used for 5 to 20 years will have some grasses, exotic weeds, and scotch broom. Sites which have not been used for over 20 years will have young trees and shrubs. These sites are usually upland.

Reed canarygrass is found over a wide range in elevation, but those sites which it dominates are usually at the upper edge of the wetlands, through the transition zone and into uplands. Stands in the open may be pure or contain other species such as sedges, common silverweed, and horsetails. It can also be the dominant understory plant in forested areas. Some seasonally flooded areas are reed canarygrass with scattered mature willow.

Grazed pasture land is usually composed mainly of grasses, with few weed species. It can be either upland, seasonally saturated, or flooded. Clumps of blackberry or wild rose are often present.

Major dredge spoil (DS) sites are Howard and Cottonwood Islands, Dibblee Point area, Hump Island, and Willow Grove. Sites may be bare land or sparsely vegetated, depending on when last used (0 to 5 years) and the amount of human disturbance. They have low to very low wildlife values, but are occasionally used as resting areas by geese and crows.

Wildlife

Black-tailed deer are the most common big game animals found along the Columbia. They are present on most of the islands and the non-industrialized portions on the Washington and Oregon mainland. Black bear are probably occasional visitors in the least developed portions, especially those with suitable habitat on the higher uplands. Table 13 shows the most common mammals by habitat type.

A number of aquatic furbearers are present in the wetter habitats, both on the islands and the mainland. Included are: beaver, muskrat, nutria, mink, weasel, and river otter. Nutria are the most numerous of the aquatic furbearers, while mink and river otter have the lowest densities.

Small mammals in the area include coyote, gray fox, bobcat, raccoon, opossum, striped skunk, eastern cottontail rabbit, and, on the Oregon side, brush rabbit. Seventeen species of small rodents have been recorded in these riparian habitats (Tabor, 1976). The vagrant shrew and deer mouse were present

Table 13. Occurrence of the Most Common Mammals along the Columbia River by Habitat Type (from Tabor, 1976).

Species	Habitat Type				
	EM	RC	GR	SS	FO
Black-tailed deer		X	X	X	X
Beaver	X	X		X	X
Muskrat	X			X	X
Nutria	X		X	X	X
Mink	X				
River otter	X	X		X	
Coyote		X	X	X	X
Raccoon	X	X	X	X	X
Opossum	X	X	X	X	X
Striped skunk		X	X	X	X
Cottontail rabbit		X	X	X	X

in all habitats and had the highest densities. The vagrant shrew was more numerous in marsh and reed canarygrass habitat while the deer mouse had highest densities in forested areas. Townsend's vole was captured in all but marsh habitat. Cottonwood and willow/cottonwood habitat had the highest diversity of species.

The portion of the Columbia River between the estuary and RM 73 is of minor importance for waterfowl. Production, as in the rest of the lower Columbia River, is limited. Nesting species include the Canada goose, mallard, cinnamon teal and wood duck. Backwater areas such as Carrolls Channel, behind Dibblee Point, the area between Hump and Fisher Islands, and the Coal Creek Slough area provide suitable nesting and brooding sites. Migratory and wintering waterfowl are present

in greater numbers than resident birds, but much larger populations are found upstream and downstream on the Columbian White-Tailed Deer, Lewis and Clark and Ridgefield National Wildlife Refuges. There is a minor amount of hunting, mainly for mallard, pintail, wigeon, and Canada geese.

Upland game birds present adjacent to the Columbia River include ring-necked pheasant, California quail, ruffed grouse, band-tailed pigeon, mourning dove, and snipe. All are present in limited numbers and little hunting occurs. Ring-necked pheasants stocked on Cottonwood Island provide a private hunting opportunity.

A number of raptors use the Columbia for nesting, food, and cover. Common species include red-tailed hawk, northern harrier, American kestrel, western screech-owl, great horned owl, and saw-whet owl. Bald eagles are common in the estuary.

Riparian vegetation, especially the mixed deciduous tree types, provides a unique habitat for passerine birds. Some of the highest densities and diversities recorded in the literature are found in riparian forested habitat. During the winter black-capped chickadee, golden-crowned kinglet, song sparrow, and winter wren were found to be the most common species. Tree swallows and Swainson's thrush were most common in the spring and summer, respectively.

A large great blue heron rookery of approximately 200-300 nests is present on Fisher Island. There are smaller rookeries downriver at either end of Puget Island and a large rookery on Karlson Island in the Lewis and Clark NWR. A small rookery has recently been established on Price Island. The medium size rookery at Deer Island is the closest upriver site.

Several species of gulls are found on and along the river year round. Included are glaucous-winged, western, California, mew, herring, and Bonaparte's gulls. They are especially numerous during the winter eulachon run. Major gull nesting and loafing areas in the estuary are East Sand Island, Rice Island, and Miller Sands. A large number of caspian terns nested on East Sand Island in 1984. Other water birds present in the river, usually in the winter, are double-crested cormorant, common loon, and western and pied-billed grebes.

Bats are present in the area, depending on availability of roosting sites (i.e., abandoned buildings, bridges, and viaducts). Species probably present include little brown

myotis, big brown bat, and Yuma myotis. Roosting sites may be outside the project area, but riparian habitats provide foraging area.

Commonly occurring amphibians and reptiles include Northern red-legged frog, long-toed salamander, Northwestern salamander, Pacific tree frog, and garter snakes.

Eruption

Little or no flooding or deposition of material on wetland or upland areas occurred along the Columbia River during the initial mudflow. Any damage to wildlife habitat was caused mainly by the tremendous amount of logs, wood debris, and volcanic rocks carried down by the mudflow.

Post-eruption

The post-eruption effects on wildlife and habitat of the Columbia River have resulted from the extensive loss of habitat due to dredge disposal (Figures 14 and 15). A pipeline dredge started working the main navigation channel 2 days after the eruption. Three other large pipeline dredges were onsite early in June, dredging the Columbia and the mouth of the Cowlitz. Work in this area was almost continuous during the next 2 1/2 years with approximately 17 mcy removed. After the navigation channel was dredged to authorized depths and widths, additional dredging (8 mcy) was done to partially restore the normal cross section of the river.

Major deposition of material dredged from the channel has occurred in Washington between the Kalama and Cowlitz Rivers. There were approximately 1,700 acres of shallow water, wetland, and riparian habitat between RM 68 and 72 prior to the eruption (Table 14). Material dredged from the lower 1.5 miles of the Cowlitz was placed on the Collins Estate. All material removed by pipeline from above about RM 67.5 was placed on Cottonwood Island and on the proposed deepwater port site below the Kalama River. As shown in Table 14, about 740 acres of the 1,700 acre area have already been filled, and another 900 acres are designated as long-term disposal. Plate 5 depicts the Collins Estate pre- and post-eruption.

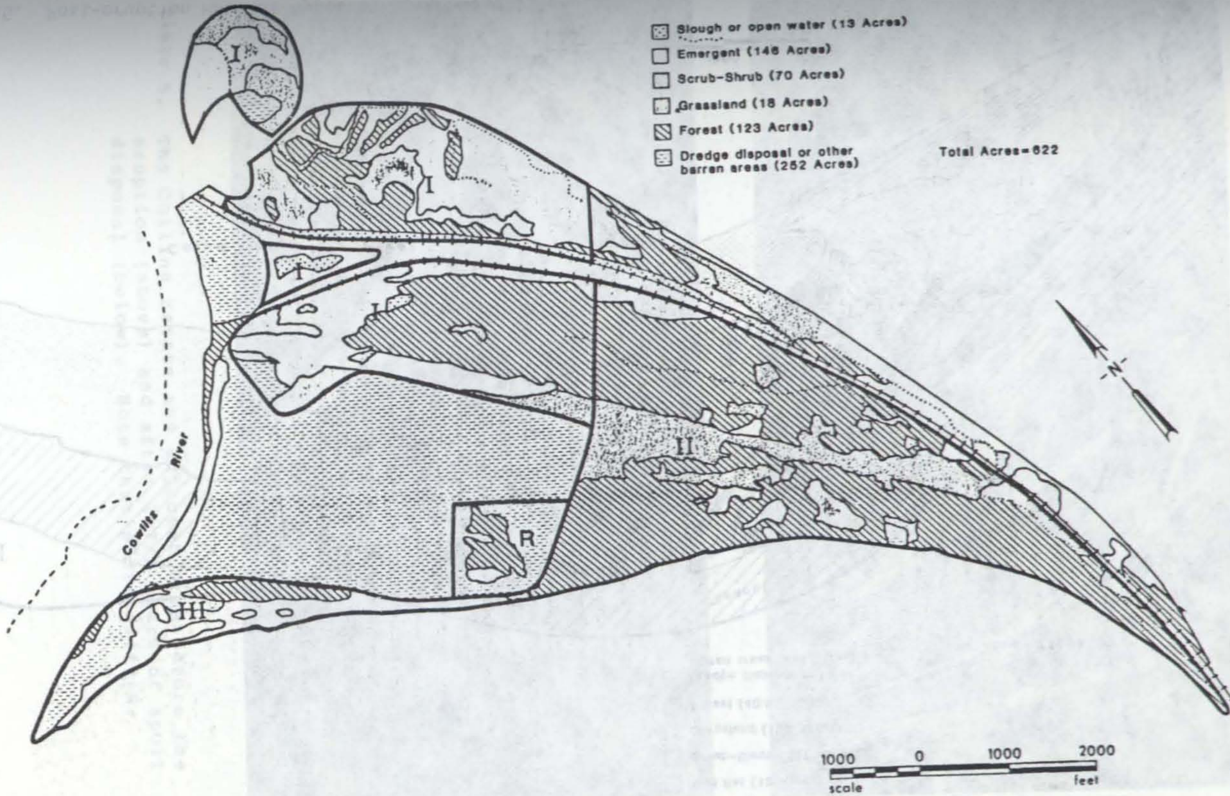


Figure 14. Post-eruption Habitat Types at the Collins Estate.

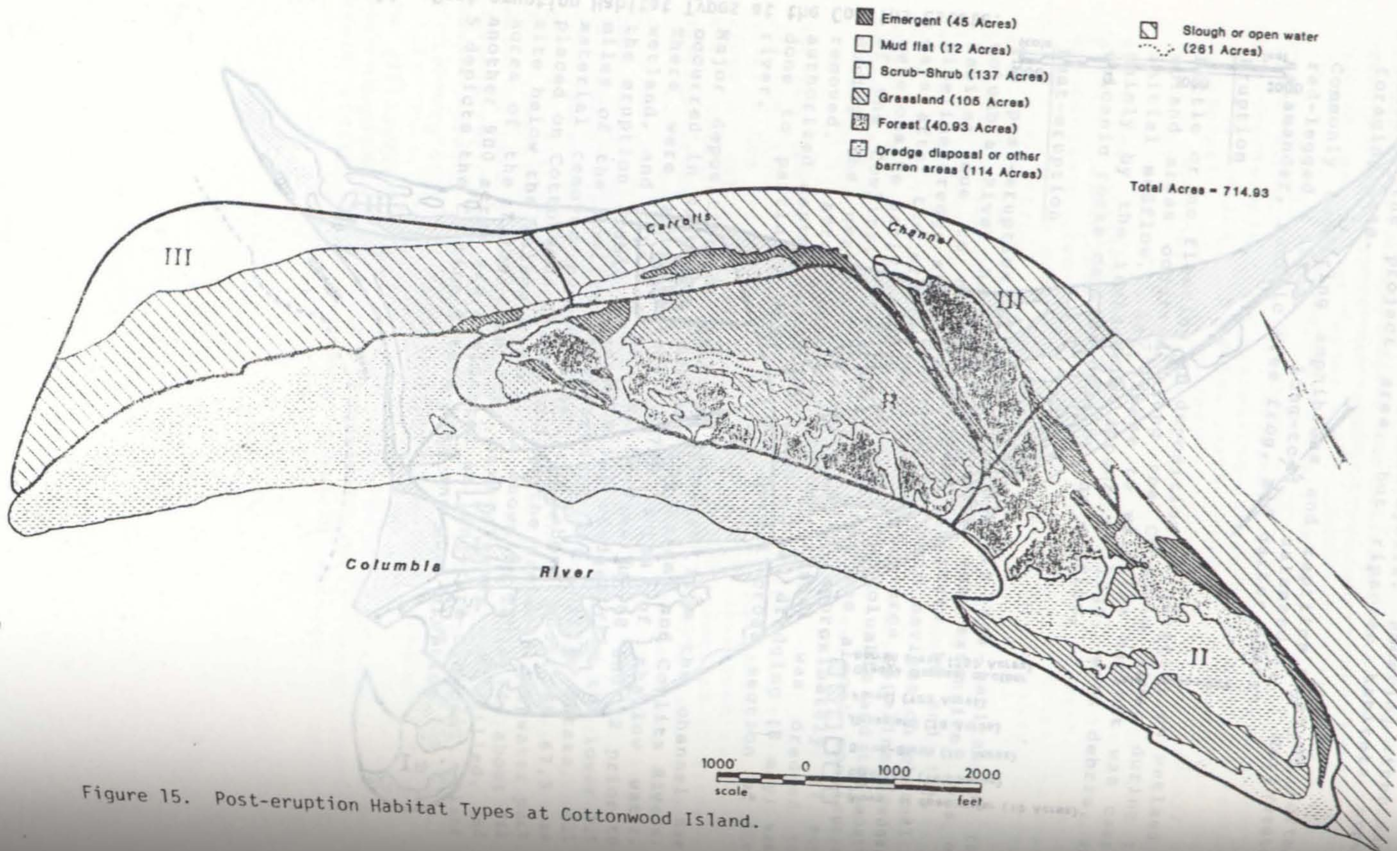
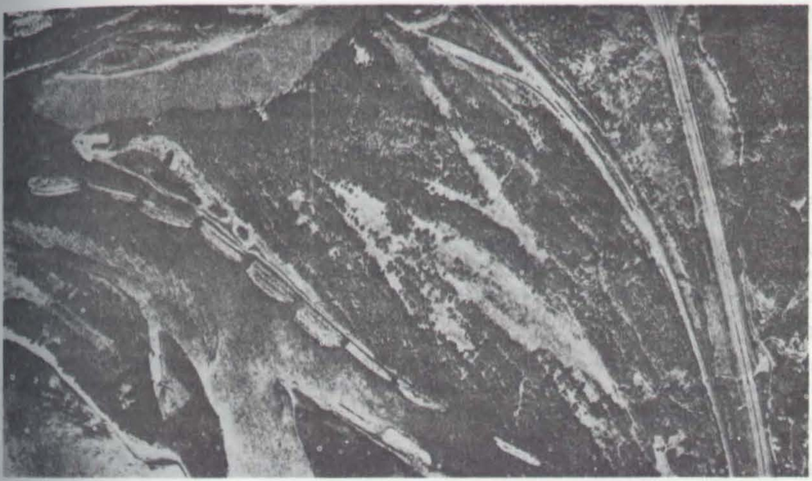


Figure 15. Post-eruption Habitat Types at Cottonwood Island.



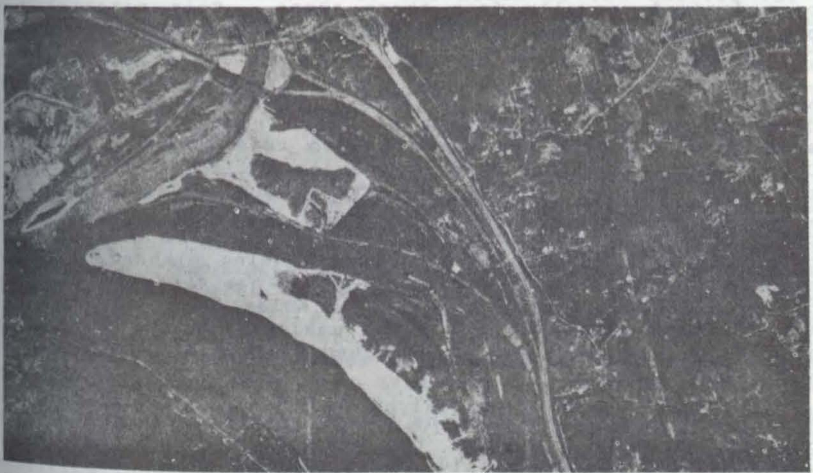


Plate 5. The Collins Estate and adjacent area before the eruption (above) and after 2-1/2 years of spoil disposal (below). Note that scale differs.

Table 14. Dredge Material Disposal Sites between Columbia RM 68 and 72

Site No.[1]/	Location	Filled (Acres)	Proposed Fill (Acres)
1	Howard/Cottonwood Island	456	
2	Cottonwood Island		472
3	BN/Port of Kalama	65	110
5	Collins Estate	220	
6	Collins Estate		98
7	Collins Estate		328
Total		741	898

1/ Sites shown on Figure 16

Sumps have been periodically excavated every fall in the mouth of the Cowlitz River to trap and remove sediment before it reaches the Columbia. Approximately 3 mcy of material have been dredged annually from these sumps. This material has been placed on the Collins Estate (site 5) or Howard/ Cottonwood Island (Site 2).

All wildlife values have been lost on Howard Island. In early dredging phases, some clumps of trees were left. However, subsequent higher lifts have negated this action. Part of Cottonwood Island has been completely filled. In addition, the cove between Howard and Cottonwood Islands (on the Carrolls Channel side) has been diked and used as a settling pond, and is now almost completely filled. The Islands have been sold with industrial development being planned. Dredge material disposal and vegetation removal has destroyed much of the wildlife habitat on the Port of Kalama/BN site (site 3). The Port now wishes to fill the remainder of the industrial site which has been heavily impacted by initial land clearing and recent filling.

Wildlife values on the Collins Estate remain high. The higher quality wetlands are under the powerlines and to the north (site 6) and have had only minor impacts so far. A small great blue heron rookery has established in the last 2 years just southeast of the current disposal site.

During initial deposition on the Collins Estate, the Corps inadvertently filled an extensive wetland along Carrolls Channel near the mouth of the Cowlitz. In the fall of 1982 some of this material was removed to partially restore the wetland. A large area was lowered about 1 foot and a channel was dug from one end of the original wetland site to the other. A pond and cove were also excavated. Recovery of the site has been far faster than expected. By summer 1983 a number of emergent wetland plants were well established in the lower areas. Major species include wapato, softstem bulrush, several species of spike-rush and bur-reed. By summer 1984, wapato densities had increased and softstem bulrush had decreased. Some high marsh plant species are now appearing on the higher areas.

A small wooded area (site 16) is being used for disposal of material dredged from the channel in the old mouth of the Cowlitz. Wildlife values of this area have been lost.

<u>Future Without the Project</u>

Without the project, dredging and disposal sites will be required in the vicinity of the mouth of the Cowlitz for a number of years. The dredging load will be heaviest the next 10 years. Based on the events of the last 4 years, dredging will not be required below about RM 63. With no action, an estimated 26 mcy would have to be dredged from this area over the next 5 years. The 50-year dredging total at this site would be 145 mcy. This estimate does not include storm events.

Exhibit 5 to Appendix D of the Corps' Feasibility Study delineates proposed dredge disposal sites, including the lower 1 mile of the Cowlitz River and the Columbia River between RM 68 and 71. The Corps Navigation Branch prepared a disposal plan for this area several months ago. There are major differences in number, size, and capacity of sites in the two plans. The Feasibility Study plan also does not correspond in size or capacity with sites actually being used for the sump dredging the winter of 1984-1985. Because of these inconsistencies in Corps of Engineers planning, documents, and actions and the lack of environmental criteria in the selection of sites, we have developed and recommended modifications to these plans.

Both hopper and pipeline dredging would probably be required to maintain the navigation channel, particularly after storm events. Use of hopper dredges would allow a wider disposition of dredged material; for example, hoppers could unload in the vicinity of RM 63 to 64 and pipeline dredges could later place this material in sites 23 or 24.

It is expected that interim measures (PL 98-63 and Cowlitz sump) will be continued, at least for some time. Dredging in the Toutle and upper Cowlitz will reduce dredging requirements in the Columbia to an estimated 17 mcy over the next 5 years and 71 mcy over 50 years. Operation of the Cowlitz sump, removing approximately 3 mcy annually, should result in no appreciable amount of material needing to be dredged from the channel, except for storm events. This appears to be what has happened the past 4 years. There are adequate disposal areas at or near the mouth of the Cowlitz for almost all of this material.

It is possible, through some series of events, that material could be carried farther down the river before it was deposited. Depending on the amounts involved, wetland/riparian/wildlife habitat along the Columbia River could be impacted. Upland disposal sites downstream are limited, i.e. much of the Washington shore is steep wooded hillsides where acceptable sites within easy range of a pipeline dredge are even more limited. Most areas bordering the river are either diked farm or pasture land or riparian/ wetland habitat. The few large areas where material could be placed with the least damage to wildlife habitat are some distance from usual shoaling areas.

The Service's HEP analysis was conducted on wetland/riparian habitat adjacent to the Columbia River from the Cowlitz to the upper end of Puget Island. The HEP analysis was based on habitat types and was not site specific. Based on the HEP, the following rankings, in order of highest value, were derived for habitat types: mature mixed forest; mature cottonwood; emergent marsh; shallow subtidal sloughs and backwaters; dredge spoil over 20 years old; diked pasture; intertidal unvegetated sand and mud flats; scrub/shrub; reed canarygrass; mature willow; mature willow/reed canarygrass; and dredge spoil 0 to 20 years old. The two highest ranked habitats are those probably most difficult to replace because of the time required for tree growth.

The species or guilds (a group of species utilizing a common resource) considered in the HEP were: aquatic furbearers,

juvenile salmonids, other fish (warmwater gamefish), passerines, food production (detritus, seeds, berries, insects), small rodents, raptors, waterfowl, deer, colonial nesting birds (mainly great blue herons), shorebirds (and marshbirds), and eagles.

The disposal sites identified by the Corps and the Service and shown in Figures 16, 17, and 18 were evaluated for suitability of use based on fish and wildlife values. The sites were classified in three categories; acceptable without mitigation, acceptable with mitigation, and unacceptable, as follows:

Acceptable without mitigation: sites 1 and 2 (except fringing marshes), 5, 10, 11, 12, 16, 20, 21, and 22.

Acceptable with mitigation: sites 3, 9, 13, 15, 18, 19, 23, and 24.

Not acceptable: sites 6 and 7.

Sites with significant wildlife resource values include part of 2, 6, 7, 9, 13, and part of 15. These areas vary in their value to wildlife. Resource Category determinations for these sites, based on Fish and Wildlife Service mitigation policies, range from Category 4 to Category 2. Mitigation goals would vary according to Resource Category, ranging from no net loss of in-kind habitat value (Category 2) to minimize loss of habitat value (Category 4).

The level of mitigation required would depend on the habitat type destroyed. High value habitat would require replacement in-kind in the vicinity of the disposal site. For lesser value habitats, options would include: habitat improvement of another area; securing through purchase, deeding or easement of another area; and revegetation of the disposal site.

Mitigation for individual sites should be determined by resource agencies, the Corps, project sponsors, and landowners before any site is used for dredged material disposal.

Future With the Project

The major impacts on wildlife would be loss of habitat due to dredge spoil disposal. The severity would depend on the amounts to be dredged and location in the system. The Feasibility Study predicts 15 mcy to be dredged from the Columbia under the preferred plan.

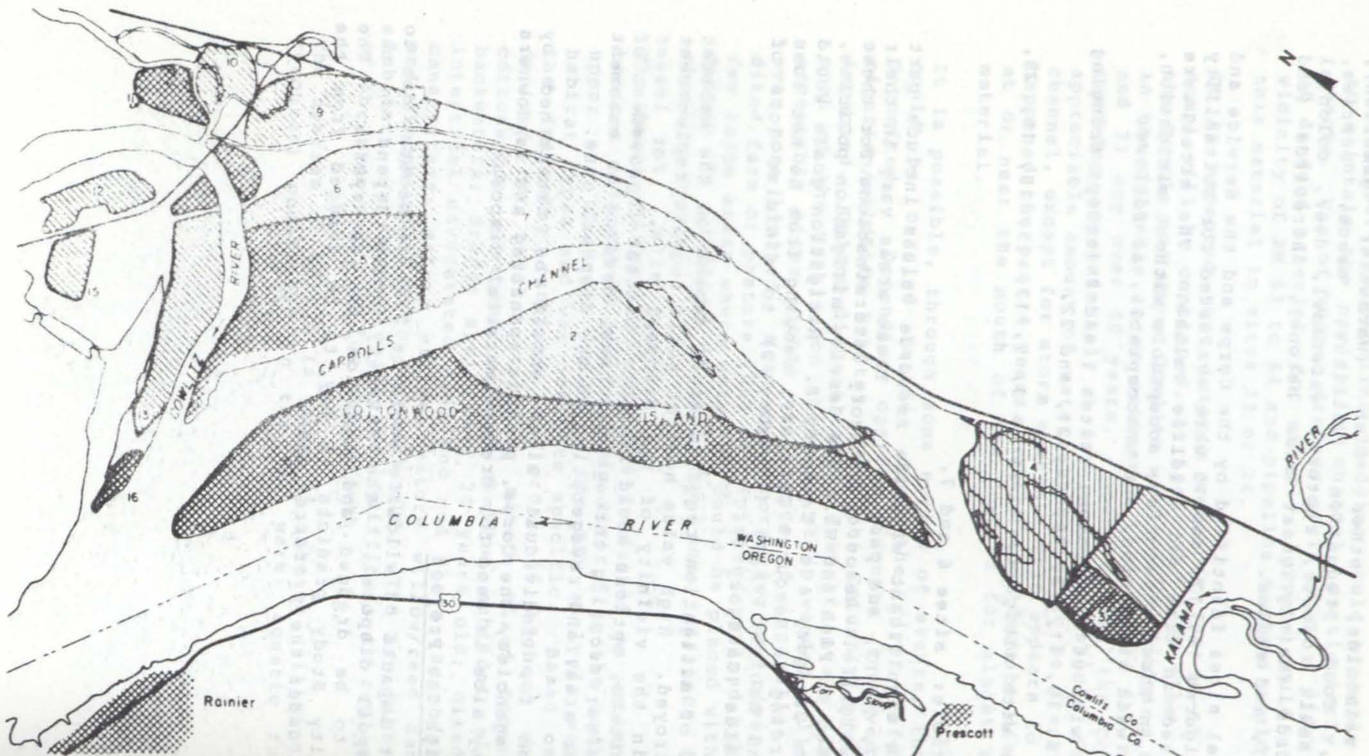


Figure 16 Dredge disposal sites.

- Proposed long-term sites
- Used as of September 1984
- Proposed mitigation sites

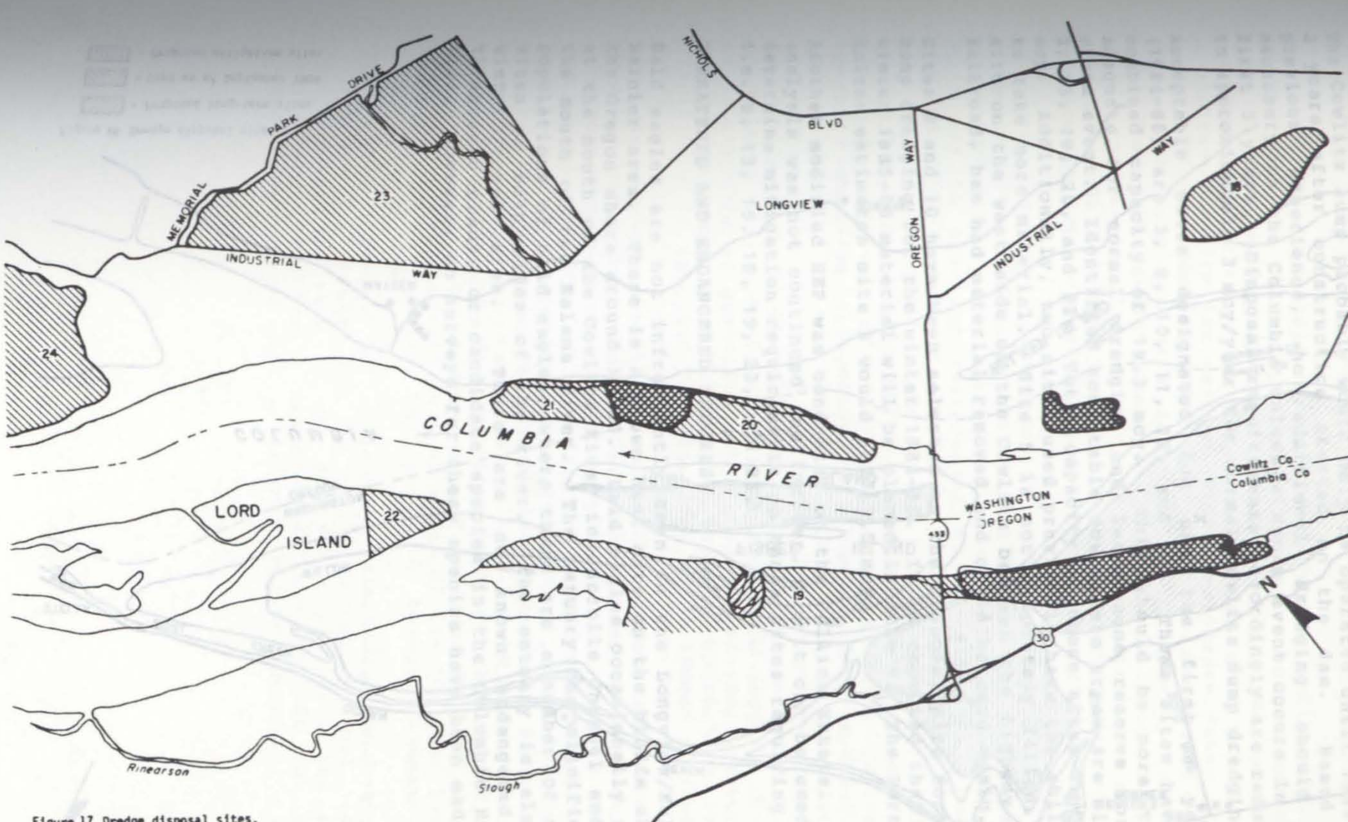


Figure 17 Dredge disposal sites.

- Proposed long-term sites
- Used as of September 1984

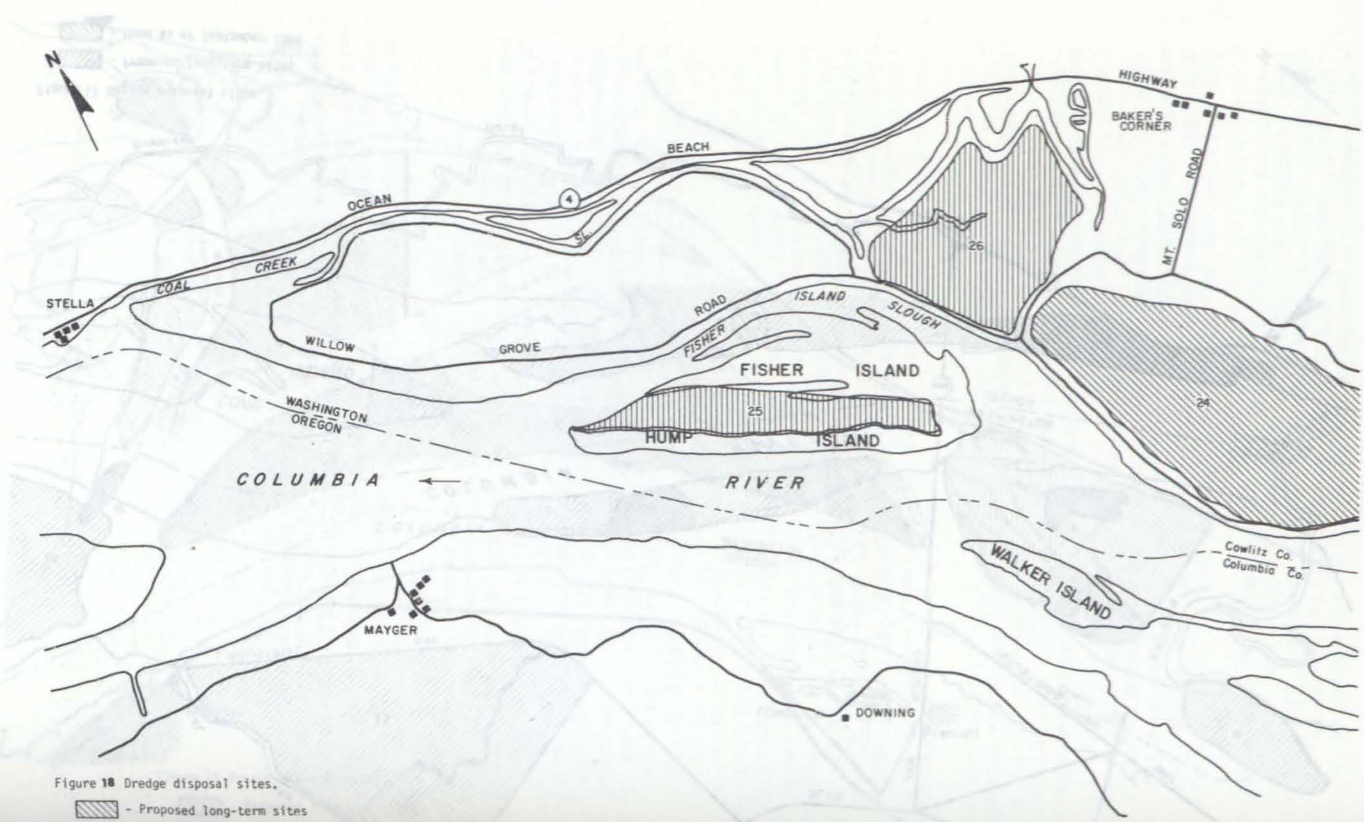


Figure 18 Dredge disposal sites.

- Proposed long-term sites

- Used as of September 1984

- Proposed mitigation sites

The Cowlitz sump probably would only be operated until 1989 or 2 years after construction started on the dam. Based on previous experience, no additional dredging should be necessary in the Columbia unless a storm event occurs in the first 5 years. Disposal requirements accordingly are reduced to approximately 3 mcy/year for normal Cowlitz Sump dredging.

Acceptable sites designated for use the first 5 years (1984-88) are 3, 9, 10, 11, 12, and 18. These sites have a combined capacity of 19.3 mcy. This should be more than adequate for normal dredging and leave some reserve for a storm event. Identified acceptable downstream areas are sites 2, 15, 19, 20, and 22. Total capacity of these sites is 55.2 mcy. Additionally, two sites used previously have the ability to take more material. Site 5 is not completely filled. A site on the west side of the Cowlitz between the highway and railroad, has had material removed and could be used again.

Sites 9 and 10 have been selected as the disposal site for the sump dredging for the winter 1984-85. It is expected that the winter 1985-86 material will be placed in site 9. The Port of Kalama estimates site 3 would hold 7.5 mcy.

Another modified HEP was conducted on the Collins Estate. The analysis was not continued any further, but it can be used to determine mitigation requirements on those sites requiring it; i.e. 9, 13, 15, 18, 19, 23, and 24.

THREATENED AND ENDANGERED SPECIES

Bald eagles are not infrequently seen in the Longview/Kelso/ Rainier area. There is a known nest site on the bluffs above the Oregon shore around RM 60. Bald eagles occasionally feed at the mouth of the Cowlitz River in Carrolls Channel and at the mouth of the Kalama River. The estuary has significant populations of bald eagles, where there are a number of nest sites on both sides of the river. The estuary is also a winter roost area. There are no known endangered or threatened plants or candidate species in the Columbia River area. However, no surveys for these species have been made.

DISCUSSION

The Green River structure is the least damaging of the proposed sediment retention dams primarily because of its upstream location in the Toutle River System. The LT-3 and Kid Valley sites are unacceptable alternatives because they would cause extensive losses of fish and wildlife resources. While losses would not be as severe with the Green River Dam, sediment inundation of important fish and wildlife habitat would occur as a result of the dam. Dredge disposal, while not as extensive as with the "no action" alternative, would still involve significant loss of wildlife habitat. Mitigation for these losses would be necessary and should be considered a project cost.

There are several opportunities and/or methods to mitigate for the project-related losses of fish and wildlife described above. Fish passage to tributaries upstream of the Green River structure, fish habitat improvement, streambank revegetation, reseeding of dredged disposal areas, and provision for public access must be considered as mitigation measures. Specific measures could be used singly or in combination to achieve full replacement of lost fish and wildlife habitat.

Continued protection of fish and wildlife throughout the life of the project will be needed. Making fish and wildlife an authorized purpose of the project will help to accomplish this goal. One method of assuring protection of these resources is to monitor construction contracts and impacts.

A monitoring program will also be necessary to assess the adequacy of mitigation measures for fish and wildlife affected by the project. Monitoring could also be used to determine a "release schedule" from Spirit Lake and to adjust management of project lands. A 25-year monitoring program consisting of 5 years of continuous monitoring with periodic monitoring at 5-year intervals to year 25 amounts to a total of about $840,000. The fish and wildlife monitoring program should include studies of the following topics:

a. Water quality

b. Streamflow

c. Fish population recovery as effected by the project

d. Aquatic food chain recovery as effected by the project

e. Stream habitat recovery upstream and downstream of the project

f. Rearing pond site evaluations

g. Fish passage success

h. Wildlife studies should include monitoring of wildlife responses to project features within the study area.

A more specific discussion of project-related mitigation measures by stream system is presented in the following paragraphs.

TOUTLE RIVER

Since the upper Toutle River System formerly supported large runs of anadromous fish and will again provide habitat for these fish after streams have recovered, passage facilities are desirable for any barriers that are constructed to trap sediment. Passage would be needed for downstream migrating juvenile salmonids as well as upstream adult migrants. Since the Green River structure is the most efficient of the dam alternatives, in terms of sediment trapping and minimization of habitat losses, the following description of fish passage facilities is specific to this site. With regard to juvenile fish passage, the ideal situation would be to have a full pool and a spillway discharge over which the fish would be transported. However, a full pool may not be possible nor advantageous if warm impounded water becomes a water quality problem downstream. Preliminary information on the design of juvenile fish facilities indicates that a regulating outlet (RO) in the dam will permit the fingerlings to pass through the dam and into a stilling basin. As sediment depth increases behind the dam, stoplogs inserted upstream of the RO trashrack, will force the water with the juveniles to drop into a wet well located just upstream of the RO. The juvenile migrants would then pass through the RO to the tailwater.

Successful passage of juvenile salmonids would require suitable conditions in the main stream channel and in tributaries upstream of any dam where sediments and ponded water would collect. These conditions include low summer water temperatures and a defined stream channel. It is

expected that flat alluvial deltas would form where sediments accumulate behind dams. The North Fork Toutle River is likely to form numerous braided shallow channels in such areas. These conditions could cause: 1) stranding of juvenile fish when river levels drop; and 2) warming of waters to lethal temperatures for salmonids. Fish passage conditions and water temperatures could be improved by confining the river to a single deep channel through the sediment collection area during the time of juvenile salmonid migration. Annual dredging may be necessary to provide such a channel.

Passage of upstream migrating adults could be accomplished by trapping and hauling adult fish around the dam. A trap and haul system would require the following structural features: 1) a holding pond and fish handling facilities; 2) a fishway entrance to the holding pond; 3) a velocity barrier or weir to direct fish into the fishway entrance; and 4) suitable vehicles to transport fish from the holding pond to a liberation point. A trap and haul system would require continued maintenance of the weir and fish holding facilities and transportation of fish. Estimates of the cost of a trap and haul operation are $1,000,000 with an annual maintenance cost of $100,000 (Appendix C).

Certain measures would also be necessary to avoid or lessen fish losses during project operations. These measures could include the following: 1) proper timing of inwater work to avoid major periods of fish migration; and 2) maintenance of an adequate stream channel through work areas to permit passage of adult fish and to prevent stranding of smolts.

Fish required to replace lost stocks could be produced at new or existing facilities, either inside or outside of the Toutle River Basin. Construction of rearing ponds to replace the Alder Creek and Deer Springs facilities would require a suitable location and source of water. Suitable rearing pond sites may or may not exist within the Toutle Basin. It may, therefore, be necessary to locate such facilities in adjacent or nearby river systems such as the Lewis or Cowlitz Rivers.

Rehabilitation of the Toutle Salmon Hatchery may also be performed when water quality and supply conditions become suitable for fish culture operations. It may be anywhere between 5 and 15 years before the hatchery is again functional, however. Therefore, cost estimates have not been provided for reopening the Green River facility. The decision to reopen the hatchery will depend largely on restoration of the watershed in terms of riparian vegetation and instream habitat conditions.

Fish losses associated with inundation of valuable habitat upstream of the Green River structure are estimated at $25,095,000 over the life of the project. Of this amount, $4,349,000 are due to loss of production in Alder, Bear, Deer, Hoffstadt, and Pullen Creeks over this period. Estimates of fish benefits due to recovery of habitat in the mainstem Toutle and North Fork Toutle River downstream of the structure amount to $18,845,000. Therefore, overall losses attributable to the Green River Dam are estimated to be $6,250,000.

Improvement of stream habitat could be used to offset losses caused by the dam. This could be accomplished by the following means: 1) stream temperature control; 2) sediment and erosion control; and 3) instream habitat improvement.

Stream temperature control could be achieved by establishing and retaining shade-providing vegetation along streams. This could be accomplished by any or all of the following measures: 1) reestablishment of trees, shrubs, and other plants along streams which presently lack riparian vegetation; 2) establishment of permanent buffer zones of vegetation along streams; and 3) easements for streamside buffer zones on privately owned lands.

Streams which are likely candidates for rehabilitation with riparian plantings include the upper portions of Miners and all of Schultz Creeks, tributaries of the Green River. WDF and Weyerhaeuser have already initiated revegetation of Elk Creek, another Green River tributary, with flowering dogwood, wild rose, and cottonwood (Mohoric, personal communication). Similar measures in other Toutle Basin streams would help to mitigate for losses of fish habitat upstream of the Green River Dam. Other candidate streams for riparian plantings include Disappointment, Trouble, Goat, and Dollar Creeks on the South Fork Toutle River. Approximately 1 square mile of riparian habitat could be restored with this measure. Costs associated with this measure are estimated to be $82,000.

Control of erosion and sedimentation could be accomplished by many of the same measures used to reduce stream temperatures. These include revegetation of streambanks and establishing buffer zones of riparian vegetation. In addition, structural measures could be implemented to control streambank erosion. These include stabilization of eroding streambanks with rock riprap, groins, or jetties.

Instream fish habitat could be restored or improved at many locations in the Toutle River System. Placement of boulders, gabions, or large organic debris such as logs or root wads would hasten stream habitat recovery by providing a diversity of pools, riffles, and instream cover for fish. Such activities have already been started, but could be expanded to other streams in the basin. Gravel cleaning to remove fine sediments would improve available spawning areas for fish. Revegetation of streambanks would provide a nutrient base for aquatic insects and overhead cover for fish. Instream rehabilitation in 20 miles each of the mainstem Green and South Fork Toutle Rivers should be considered as mitigation for the loss of 9 miles of productive habitat ($4,349,000 value) in Alder, Bear, Deer, Hoffstadt, and Pullen Creeks and 5 miles of the North Fork Toutle River. Placement of woody debris, gabions, or boulder grouping in these rivers would cost between $60,000 and $212,000, depending on the stream rehabilitation method used. Other streams downstream of the dam (see following paragraphs) may also be suitable for restoration work.

Potential spawning and rearing habitat for anadromous fish exists upstream of impassable water falls in the Green River and other Toutle System streams. Fish passage could be provided around such obstacles to offset losses of spawning and rearing habitat caused by sediment inundation upstream of the Green River Dam. Passage could be provided by blasting the falls to reduce their gradient, selective blasting to provide a passage channel, or constructing fish ladders (Plate 6). Passage improvement sites exist at Thirteen Creek Falls (near the mouth), Devils Creek (blasting-cutting above the #500 road bridge), and at an unnamed South Fork tributary (Section Lines 22 and 23, T9N, R2E). These improvements, i.e. ladders at Thirteen Creek and at the South Fork tributary and blasting at Devils Creek, would open an additional 7 miles of spawning and rearing habitat for coho salmon. Costs for these improvements are estimated to be about $101,000.

Wildlife habitats upstream of the proposed SRS should be maintained as long as possible, both in the sediment inundation zone and in the buffer zone (i.e., throughout the 7,450 acres). This includes maintenance of habitat conditions outlined in Figure 9. Most importantly this should include cessation of timber harvest. Debris and trees killed by sediment inundation should remain to provide snags for wildlife. Debris should be removed only on an as needed basis to protect the SRS. As this material moves downstream, it will help to stabilize the riverbed, provide instream habitat,

Plate 6. Elk Creek before fish passage was improved. Available habitat for anadromous fish could be increased by improving fish passage at waterfalls.

and act as a detrital nutrient source. Land owned by the CE behind the SRS that will not be inundated by sediment should also be maintained for wildlife throughout the life of the project. Maintenance of these lands will partially offset habitat losses due to sediment inundation.

As dredge disposal proceeds, creation of varying contours, seeding, and fertilizing will provide conditions suitable to wildlife habitat development. This is particularly applicable to downstream areas LT-1 and LT-3. Contouring disposal material to favor wetland development and herbaceous and woody plantings would hasten recovery after disposal. (Some wetland re-creation has already been attempted with some success along the Columbia River by the Portland CE). Almost all the land within LT-1 and some of the land at LT-3 is owned by the state. The Washington Department of Natural Resources (DNR) has indicated a willingness to consider maintenance of some areas for wildlife after disposal and the above mitigation measures are implemented. Although portions of these lands may ultimately be developed for recreation (e.g. picnicking and fishing access), maintenance of wildlife habitat need not be imcompatible with these uses (Smith, personal communication). Further coordination as disposal is placed and the DNR finalizes plans for these areas is needed.

The CE Waterways Experimental Station has developed guidelines on material placement for marsh creation (Johnson and McGuinnes, 1975) which should be used in dredge disposal material placement. Costs associated with this measure are about $98,300.

To offset loss of habitat covered by sediment at the SRS site, the area should be periodically reseeded (i.e. throughout the life of the project). A Dutch white clover/orchard grass/red clover/ red fescue mix with a fertilizer application of 100 lbs. of 10-20-20 per acre should be used. Liming may also be necessary in some instances.

Woody plantings such as ninebark, huckleberry, salal, and Oregon grape should be planted in areas outside the sediment zone but within CE ownership to offset forage losses in the sediment retention zone. This should also include expansion and maintenance of existing herbaceous vegetation, including fertilization at the base of the debris slope (outside the National Volcanic Monument). Seeding of the debris slope will offset losses of elk feeding areas within the project area. Following project completion (50 years), the entire area should be seeded and planted to hasten recovery.

Temporary protection or easements along the Green River, South Fork Toutle River, and Hoffstadt Creek drainages should be considered to offset habitat losses before final mitigative measures begin. Specifically, this should include cessation of timber harvest. This protection would be dropped as mitigation measures are implemented.

While it is recognized that stabilization of the Toutle River downstream from the project will speed recovery of riparian vegetation, we do not believe this improvement can be quantified. As a result, it is not specifically included in our mitigation analysis.

COWLITZ RIVER

Construction of the sediment retention structure project will enable the Cowlitz River to begin to return to pre-eruption conditions within a relatively short time. In addition to the structure, there are other actions which can be taken to accelerate the recovery process.

A major source of continued sediment flow will be lateral instability of the Cowlitz River. As soon as possible after sediment flow from the debris avalanche is halted, steps should be taken to stabilize the Cowlitz. This would be particularly suitable in areas where the river is not tightly confined between levees or riprapped areas. Willow, alder, and cottonwood shoots can be placed in low velocity areas. Bank areas could be seeded with grasses and legumes, with a program of annual fertilization. Reestablishment of riparian habitat would help prevent lateral erosion, provide temperature modification, insect and detrital input for aquatic species, and food and cover for terrestrial species.

Several actions could be taken to restore wildlife habitat. During the final deposition at a particular spoil site, especially those owned by the State of Washington and adjacent to the river, the spoil area should be shaped with irregular contours, both vertically and horizontally. Revegetation of sand at other dredge disposal locations has shown that grasses get a better start in depressions. Disposal areas should be seeded with appropriate grasses and fertilized annually. After a humus layer has begun to form, shrub and tree species could be planted to provide wildlife habitat. The Cowlitz County SCS agent and WDG should be consulted regarding species, grass mixtures and rates, and fertilizer rates.

Public access to the river for fishing and viewing should also be provided on these disposal sites.

COLUMBIA RIVER

The alternatives with the least impact on Columbia River fish and wildlife would be the Single Retention Structures which retain all of the sand size and larger material. Included are Kid Valley, height 318 and Green River, height 177, 202, and 272. Green River heights 177 or 202 are the preferred alternatives for the Columbia system. This, along with PL 98-63 actions and Cowlitz Sump, will allow the least amount of sand size sediment into the Columbia River. It would also minimize the dredging and disposal requirements for maintaining navigation and would reduce the deposition of sediment in shallow water areas and in the Columbia River Estuary. However, since the dams are not designed to retain fines, there is little that can be done to reduce the impact of deposition of fines in the estuary and other shallow water areas.

Inwater disposal sites should be located where the least amount of material would be deposited in highly productive shallow water areas. Sumps could be located in other places, such as off Barlow Point. Material from this sump could be placed in disposal site 24.

Our prioritized list of disposal sites at the mouth of the Cowlitz is as follows: 3, 1, 5, 11, 10, 2, 18, 15, 9, and 13 (Figures 16 and 17). Mitigation has already been agreed upon for the loss of wetlands at site 3. The Port of Kalama has in the past offered to pay the difference in the cost of pumping to this site. Site 9, which is presently being used, was given a low priority because the requested mitigation planning for this site has not been initiated. However, this site would be considered acceptable with implementation of appropriate mitigation actions. The first 6 sites on this prioritized list would provide 62.3 mcy capacity, which is more than adequate for the preferred plan.

Mitigation requirements for those sites that are acceptable with mitigation should be determined using HEP. Mitigation should be determined for individual sites through coordinated planning by the resource agencies, the Corps, the project sponsor, and affected landowner. Mitigation requirements and an agreement as to how they are to be met should be agreed upon before any of the sites are used.

Mitigation options are limited in the area. The major habitat types of concern are emergent wetlands and mature forested. First priority would be to create wetlands to replace those lost. Restoration of detrital input into the Columbia River system is particularly important. There are 2 possible wetland creation sites. One would be to enlarge the existing site on Carrolls Channel. At least 3.6 acres of wetland could be created. Site 25 is another possible wetland creation site. Because of its value to juvenile salmonids, this area should be only partially filled. An estimated 60 acres of wetlands could be created along Fisher Island and at its upstream end. This action would be consistent with the Cowlitz County Comprehensive Plan and the Shorelines Management Master Plan. The log rafting area at this site is leased to Knappton Corporation. Consideration for that use would have to be addressed during development of a wetland creation plan. Fill needed to create the wetland could be obtained from channel maintenance dredging or from maintenance dredging of the Longview waterfront.

Preservation of existing wetland or wildlife habitat should be considered as a mitigation option. This could be accomplished by outright purchase, deeding to wildlife uses or easements. Two possible sites are 4 and 26. Both of these areas are moderate to high value habitat, but have some possibilities for increasing values. It is this increase in habitat value, not preservation alone, that provides mitigation credit. Parts of site 4 have already been designated as mitigation for two developments by the Port of Kalama. Site 26 is owned by the Port of Longview, a project sponsor. Wally's cove, a 4-acre wetland in site 19, was filled last fall. Mitigation for loss of this wetland is possible in the slough at the downstream end of the site.

A task group of resource agencies, the Corps, project sponsors, and the county should be formed to determine detailed mitigation requirements, mitigation sites, and actions to be taken. It had not been possible to do this earlier due to time constraints and delay in receipt of project data from the Corps. Now that an alternative has been selected, a more definite idea can be formed of disposal sites which are feasible to use, i.e. are available, are environmentally acceptable, etc.

The task group should be formed as soon as possible to begin working on mitigation plans. The HEP should be completed for additional disposal sites and proposed mitigation sites, so

that specific mitigative actions can be determined. It is expected that this can be done concurrently with detailed planning for the structure at an estimated cost of $50,000. Portions of the mitigation plan should be implemented immediately to offset habitat losses as most of the losses will occur in the next 5 years.

The cost to mitigate for the impacts of dredge spoil disposal would be determined in developing the detailed mitigation plan. However, based on the cost of mitigation actions undertaken in similar situations, they would be expected to range from about $250,000 to $1.5 million for the impacts to riparian and wetland habitat from dredging at the mouth of the Cowlitz River. At the low end of this range, it is assumed that mitigation can be accomplished on an available land base through management of vegetative cover and relatively minor control of water levels. The high end of this range assumes that mitigation lands would have to be acquired and significantly modified through changes in elevation and structural control of water levels. Obviously, mitigation costs for dredge spoil disposal can be minimized simply by careful consideration of the disposal location and impacts. The prioritization of disposal sites as discussed herein has been developed accordingly.

A summary of costs associated with all recommended mitigation measures is contained in Table 15.

Table 15. Estimated Costs for Mitigation Measures Associated With the Proposed Project

Mitigation Action	Time Period	Cost
Instream Work:		
Gabions	Year 1-10	$ 90,000
Woody debris placement	Year 1-10	60,000
Boulder groupings	Year 1-10	212,000
Passage:		
Blasting	Year 1-10	500
Ladders (2 streams)	Year 1-10	100,500
Trap and haul	Year 1	1,000,000
O&M	Varies	100,000
Riparian Plantings:	Year 1-10	180,000
Monitoring:		
Continuous for 5 years with periodic monitoring every 5 yrs. to year 25	Year 1-25	840,000
Habitat Replacement:		
For dredge spoil disposal		250,000-1,500,000

RECOMMENDATIONS

The following recommendations are based on information provided by the Corps of Engineers describing the preferred alternative at the Green River site and the interim dredging activities downstream of the dam. Based on the severity of their adverse impacts to fish and wildlife, as detailed in the text, the LT-3 and Kid Valley dam sites (both MRS and SRS) are not acceptable. The Green River structure appears to be the least damaging alternative; however, mitigation must be provided for the losses of fish and wildlife habitat caused by this structure. Preferred dredged material disposal sites have also been identified which would minimize adverse impacts to fish and wildlife as well as associated mitigation requirements.

Recommendations are presented in two sections--General and Specific. General recommendations would apply to all lands and waters in the affected study area. Specific recommendations address particular aspects of fish and wildlife mitigation in the Toutle, Cowlitz, or Columbia River Systems.

GENERAL RECOMMENDATIONS

It is recommended that:

1. If a SRS is considered necessary, then the Green River site be given preference for construction of a dam. The LT-3 and Kid Valley sites should be rejected because dams at these sites would produce unacceptable losses of fish and wildlife resources and habitat.

2. Fish and wildlife be made an authorized purpose of the project to ensure that action is taken to plan and implement appropriate mitigation measures.

3. In keeping with the requirements of the Fish and Wildlife Coordination Act, all capital and operation and maintenance costs for fish and wildlife mitigation be treated as an "integral part of the cost of the project."

4. All lands, water, and interests therein to achieve mitigation goals be acquired by the federal construction agency as stipulated in Section 3(c) of the Fish and Wildlife Coordination Act.

5. Necessary fish and wildlife studies and associated funding be included in any future authorization for the preferred alternative.

6. The Corps of Engineers provide funds to fish and wildlife agencies to monitor construction impacts and the effectiveness and adequacy of mitigation programs for fish and wildlife. Approximate costs for a 25-year study which includes 5 years of continuous monitoring with periodic monitoring at 5-year intervals for 20 years thereafter amount to $840,000. A monitoring program for fish and wildlife should include studies of the following topics.

   a. Water quality

   b. Streamflow

   c. Fish population recovery as affected by the project

   d. Aquatic food chain recovery as affected by the project

   e. Stream habitat recovery upstream and downstream of the project

   f. Rearing pond site evaluations

   g. Fish passage success

   h. Wildlife studies should include monitoring of wildlife responses to project features within the study area.

   Fish and Wildlife monitoring would be done concurrently and in cooperation with the Corps' 25-year project monitoring efforts.

7. The Corps of Engineers modify mitigation measures if results of monitoring studies find such changes to be warranted.

8. Construction and non-emergency dredging activities be scheduled to protect fish and wildlife (i.e., inwater work periods, etc.). Construction techniques to protect fish and wildlife as specified by federal and state resource agencies should be incorporated in construction contracts. Contract inspection efforts should include participation by fish and wildlife biologists. This is estimated to cost $80,000 annually over the 2-year construction period. This amount is included in the monitoring program cost detailed in Recommendation 4.

9. Existing habitats of high value to wildlife not be used as disposal sites for dredge spoils.

10. Areas of lower value to wildlife such as diked pasture and/or old dredge spoil disposal sites be used for dredge spoil disposal.

11 Herbaceous and woody vegetation be established on dredge spoil areas immediately after spoil is deposited.

12. Wetland creation in dredge spoil areas be investigated and implemented where feasible.

13. Loss of important fish and wildlife habitat due to project impacts be mitigated by development and/or improvement of other areas.

14. The property behind the Green River structure be managed for fish and wildlife and recreational uses thereof.

SPECIFIC RECOMMENDATIONS

Toutle River

It is recommended that:

1. Successful passage be provided for anadromous fish at all barriers erected to trap sediments. Passage would be required for downstream migrating juvenile salmonids and adult fish moving upstream. Planning for and final design of such mitigation facilities must be approved by the resource agencies prior to construction of any sediment retaining structure. A trap and haul facility for adults would cost an estimated $1,000,000 in addition to annual operation and maintenance costs of $100,000. Downstream passage costs are not available.

2. When feasible, a single defined stream channel be maintained in summer through impounded sediments to improve adult and juvenile fish passage.

3. A stream channel designed to permit fish passage and prevent stranding of adult and juvenile salmonids be maintained through all work areas (including the LT-1 and LT-3 dredging sites).

4. Rearing ponds be constructed to mitigate losses of Alder Creek and Deer Springs fish facilities inundated by sediment.

5. Riparian and instream habitat be improved at project cost at sites downstream of the Green River Dam to mitigate for project-related losses of instream and riparian habitat. Possible sites for riparian plantings include Disappointment, Trouble, Goat, and Dollar Creeks at a cost of about $82,000. These restoration measures should be implemented concurrently with the 2-year dam construction period. Suitable instream habitat improvement sites include, but are not limited to, the mainstem Green and South Fork Toutle Rivers, Devils and Thirteen Creeks, and at an unnamed South Fork tributary (Section Lines 22 and 23, T9N, R2E). Costs for the mainstem work would range from $60,000 to $212,000 and for the passage improvements about $100,000. The final selection of suitable mitigation measures and sites should be accomplished through a coordinated planning effort involving the Corps, affected landowners, public land management agencies, and fish and wildlife agencies.

6. Wildlife habitat within the sediment storage area upstream of the SRS be maintained as long as possible. Lands outside the sediment inundation zone, but within Corps ownership, should also be maintained for wildlife. Timber harvest should cease on this land to minimize the impact of wildlife lost gradually over the 50-year project life.

7. The LT-1 and LT-3 disposal sites be finished in irregular contours, seeded, planted to woody vegetation, and fertilized to aid in erosion control and development of wildlife habitat. Costs associated with vegetative plantings are about $98,300.

8. Periodic seeding and fertilization of the sediment inundation area with Dutch white clover, orchard grass, and red clover mix continue throughout the life of the project.

9. Elk forage such as ninebark, huckleberry, salal, and Oregon grape be planted on Corps lands outside the sediment inundation zone to replace forage lost to sediment coverage.

10. Existing herbaceous vegetation be maintained at the base of the debris avalanche. Any part of the seeded debris avalanche which is under Corps ownership should be maintained to benefit deer and elk.

11. Temporary protection of existing riparian vegetation along the Green River, North Fork Toutle River, and upper Hoffstadt Creek drainages be established to offset wildlife habitat losses within the sediment inundation zone. The major action needed would be cessation of timber harvest in the riparian zone. This protection would begin at the time of project construction and would be dropped as mitigation is implemented. Specific actions should be developed through a cooperative planning effort involving the affected landowners and fish and wildlife agencies.

Cowlitz River

It is recommended that:

1. Disposal areas be finished in irregular contours to increase habitat diversity.

2. Eroding streambanks and dredge spoil disposal areas be fertilized and revegetated immediately with herbaceous and woody plants.

3. Public access be provided to State owned or managed disposal areas.

Columbia River

It is recommended that:

1. As much bedload material as possible be kept out of the Columbia River System, and especially the estuary by:

   a. Operation of the Cowlitz River Sump;

   b. Establishment of sumps in the Columbia where there are adequate upland disposal sites.

2. In-water disposal sites for dredge spoils be located where material would not be deposited in shallow water areas or entrances to sloughs and backwaters.

3. Dredged materials be disposed of in the following sites in order of priority; 3, 1, 5, 11, 10, 2, 18, 15, 9, and 13 (Figures 16 and 17).

4. Mitigation for habitat values lost be required before use of sites 2, 9, 13, 15, 18, 19, 23, and 24. Assuming that

some of these sites are used for dredge spoil disposal, the estimated mitigation cost for this measure would range from $250,000 to $1.5 million.

5. A plan be developed under the authority of the Fish and Wildlife Coordination Act which identifies specific actions needed to mitigate for impacts of dredging and dredge material disposal. This plan should be guided by a task group of interested agencies, and should be developed to address both short- and long-term dredging needs and concerns. The plan would cost an estimated $50,000 and should be developed concurrently with detailed planning for project facilities (approximately 12 months). As the construction agency, the Corps would be responsible for implementation of mitigation measures identified through this planning process. These measures should be implemented concurrently with project dredging activities.

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APPENDIX A. Basis for Calculations Used to Estimate Chronology and Value of Fish Recovery

SPRING CHINOOK*

PRELIMINARY ESTIMATE OF RECOVERY CHRONOLOGY

Year	Adults
1983	20
1988	50
1993	150
2020	500

POTENTIAL RECOVERY VALUE

Catch: Escapement 3:1 - 375:125
43% Commercial (161) x $34.80 = $ 5,611
57% Sport (214) x $295 = 63,056

TOTAL $68,667

* The values expressed above only signify potential natural production could be increased 20 times when Washington Department of Fisheries reopens their Deer Springs rearing ponds.

CUTTHROAT

	Area (M^2)	Adults*
Hoffstadt	132,312	794
Bear	49,054	294
Deer	25,753	154
Jackson	18,640	112
Castle	29,432	177
Coldwater	51,507	309
Alder	51,507	309
Other tributaries	49,054	294
North Fork Toutle	441,486	441
TOTAL		2,884

* Estimated at 6 smolts/100m^2 except main North Fork where 1 smolt/100m^2 and 10% smolt/adult survival

POTENTIAL RECOVERY VALUE

Catch: Escapement 2:1 - 1,923:961
100% Sport (1,923) x $36 = $69,228

PRELIMINARY ESTIMATE OF RECOVERY CHRONOLOGY

Year	Adults
1983	50
1988	250
1993	400
1998	600
2020	2,884

COHO

	Area (M^2)	Adults*
Alder	23,161	718
Hoffstadt	24,642	764
Bear	49,054	1,521
Deer	8,870	275
Jackson	18,639	578
Castle	29,432	912
Coldwater	51,506	1,598
Other tributaries	49,054	1,520
North Fork Toutle	354,816	10,999
	TOTAL	18,885

* Estimated at .31 smolts/m^2 (3/100m^2) and 10% smolt/adult survival

POTENTIAL RECOVERY VALUE

Catch: Escapement 7:1 - 16,524:2,361
64% Commercial (10,575) x \$8.98 = \$ 94,964
36% Sport (5,949) x \$107. = 636,504

TOTAL \$731,468

PRELIMINARY ESTIMATE OF RECOVERY CHRONOLOGY

Year	Adults
1983	100
1988	150
1993	650
1998	1,027
2020	18,885

STEELHEAD

	Area (M^2)	Adults*
Hoffstadt	132,312	318
Bear	49,054	118
Deer	25,753	62
Jackson	18,640	45
Castle	29,432	71
Coldwater	51,507	124
Alder	51,507	124
Other tributaries	49,054	118
North Fork Toutle	441,486	1,060
	TOTAL	2,040

* Estimated at 4 smolts/100m^2 and 6.0% smolt/adult survival

POTENTIAL RECOVERY VALUE

Catch: Escapement 3:1 - 1,530:510
100% Sport (1,530) x \$214 = \$327,420

PRELIMINARY ESTIMATE OF RECOVERY CHRONOLOGY

Year	Adults
1983	50
1988	150
1993	250
1998	450
2020	2,040

POTENTIAL PRODUCTION ABOVE THE SRS

FALL CHINOOK

	Area (M^2)	Adults*
Alder	23,161	602
Hoffstadt	24,641	640
Bear	49,054	1,275
Deer	8,870	230
Jackson	18,640	485
Castle	29,432	765
Coldwater	51,507	1,339
Other tributaries	49,054	1,275
North Fork Toutle	354,816	9,225
	TOTAL	15,836

* Estimated at .26 smolts/m^2 (2.6 $100m^2$) and 10% smolt/adult survival

POTENTIAL RECOVERY VALUE

Catch: Escapement 6:1 - 13,574:2,262				
80% Commercial	(10,859)	x $34.80	=	$377,893
20% Sport	(2,715)	x $107.	=	290,483
		TOTAL		$668,376

PRELIMINARY ESTIMATE OF RECOVERY CHRONOLOGY

Year	Adults
1983	50
1988	75
1993	125
1998	2,000
2020	15,386

APPENDIX B. Habitat Evaluation Procedure

The Habitat Evaluation Procedures (HEP) were developed as a tool for evaluating project impacts and as a basis for formulating recommendations for mitigation. The HEP were used to evaluate the Green River SRS project impacts and mitigation needs.

Pre-field activities consisted of selecting an evaluation team (representatives from the Washington Department of Game, Corps of Engineers, and Fish and Wildlife Service participated) cover mapping, and evaluation species selection. Team members evaluated baseline habitat values in the field for the evaluation species and determined future habitat conditions for the life of the project (50 years). Habitat values were annualized to depict changes in habitat value over time, (such as dredge material disposal at LT-1 or sediment in-filling at the SRS). Impact analysis identified losses over time. Compensation plans were developed based upon the estimated habitat losses.

Two scenarios were developed for the Green River project site: 1) future conditions at the project site without the project and 2) future conditions at the project site with the project. Details of the predicted future conditions are included in Appendix B. Essentially, the future without condition assumed no major changes in land use from the present. Commercial timber harvest would continue on most of the area and natural succession would continue in areas not affected by timber harvest. The LT-1 and LT-3 sites would still receive dredge disposal (in accordance with flood control and navigation requirements outlined in PL 98-63). Minimal to no artificial revegetation would occur at these sites.

The future with the project condition included project features to offset wildlife habitat losses and was calculated using the preferred CE alternative (965 feet elevation, spillway height 177 feet, real estate purchase of 7,450 acres). This future condition assumed habitats would be maintained as long as possible behind the structure (e.g. cessation of timber harvest before and after purchase by the federal government). Herbaceous plant seeding would occur periodically throughout the life of the project at both the SRS sites and at downstream disposal sites. Dredge disposal at the LT-1 and LT-3 sites would be contoured to create wildlife and wetland habitats. Trees would be planted to hasten recovery at LT-1 and LT-3.

PROJECT WITHOUT CONDITIONS

Green River SRS Site

In Target Year 1

All cover types are assumed to be the same as baseline. Almost all land in the project area is publicly owned or owned by commercial timber companies. No major change in ownership is expected in the foreseeable future.

In Target Year 5

All cover types are expected to remain unchanged with the exception of the mature forest cover type. Mature Forest is expected to be harvested by TY 5 and be in reproduction forest. (See Managed Timber Harvest Schedule).

In Target Year 10

All cover types are expected to remain the same as baseline habitats with the following exceptions:

1. Mature Forest will be in reproduction age class with a mean HSI value for baseline reproduction forest.
2. Riparian Forest is expected to have been harvested and in a reproduction forest age class. HSI is expected to be comparable to a logged riparian site observed during baseline evaluation (Riparian #4).
3. Other Forest is expected to be harvested by this time and be in reproduction forest. Virtually all of the project area and surrounding area has been logged at one time or another. This trend is expected to continue.

In Target Year 25

1. Urban area is expected to double in size by this time. However, on an overall basis, urban growth is expected to be minimal.
2. Grassland/Pasture is not expected to increase. Most of these areas are associated with homes and small farms. The majority of land in the area is expected to remain in private timber company ownership or public ownership.

3. Reproduction Forest at baseline evaluation is now expected to be in pole stage (See Managed Timber Schedule); HSI will equal mean value for pole forest cover type. Acreage will remain at baseline levels.

4. Pole Forest type is expected to be reaching maturity. HSI will be the mean value for Mature Forest at baseline. Acreage is expected to remain the same.

5. Mature Forest type will be in Reproduction Forest (See Managed Timber Harvest Schedule). HSI values will equal baseline reproduction forest values. Acreage will be the same as baseline.

6. Riparian Forest will be in pole and slightly older stages. HSI will be comparable to Riparian Site #3, observed during baseline evaluation.

7. Barren cover type is reduced based upon predicted natural succession assumptions. It will be reduced by 1/4.

8. Disturbed Revegetated habitat will be increased by the acreage Barren cover type is reduced.

In Target Year 50

1. Urban area will have doubled in size; HSI value will be the same as baseline.

2. Grassland/Pasture acreage will remain same as baseline and HSI will remain same as baseline. Most land in the area is owned by timber companies, or publicly owned; private holdings are not expected to increase.

3. Reproduction Forest is expected to be in pole stage (See Managed Timber Harvest Schedule); HSI will be equal to HSI for Baseline Pole Forest. Acreage will be same as baseline.

4. Pole Forest is expected to have reached maturity before TY 50 and to have been replanted. (See Managed Timber Harvest Schedule). HSI will equal baseline reproduction forest. Acreage will be same as baseline.

5. Mature Forest is expected to have reached maturity before TY 50 and to have been replanted by TY 50 (See Managed Timber Harvest Schedule). HSI will equal baseline reproduction forest. Acreage will be same as baseline.

6. Riparian Forest is expected to be in late pole stage - early maturity; HSI will be comparable to riparian site seen on field studies (Riparian Forest Site #2). Acreage will be the same as baseline.

7. Forest Other - will be logged earlier (TY 10) and will be in Reproductive Forest.

8. Barren acreage is expected to be reduced by 1/2; HSI same as baseline (See Natural Succession Assumptions).

9. Revegetated will be increased by the amount Barren habitat is reduced; acreage is expected to be mature broadleaf forest; HSI will reflect Broadleaf site observed during field observation (BL #2).

PROJECT WITHOUT CONDITIONS

(PL 98-63) LT-1

In Target Year 1

Entire area will be covered with dredge disposal material; entire area will be barren. HSI will be same as mean HSI at baseline for Barren.

In Target Year 5

Entire area will be covered with dredge disposal material; entire area will be barren.

In Target Year 10

Dredge disposal in the area will have been completed. Approximately 1/2 of the area will be revegetated; HSI will be Disturbed Revegetated Mean HSI from baseline evaluation. Remaining area will be barren.

In Target Year 25

Approximately 3/4 of the area will be revegetated; 1/4 will be barren. HSI's for both cover types will equal baseline Mean HSI's.

In Target Year 50

All of the area is expected to be revegetated. HSI will equal baseline Mean HSI for Disturbed Revegetated.

PROJECT WITHOUT CONDITIONS

(PL 98-63) LT-3

In Target Year 1

Entire area will be covered with dredge disposal material; entire area will be barren. HSI will equal baseline HSI for Barren.

In Target Year 5

Entire area barren; same as TY 5/LT-1.

In Target Year 10

Dredge disposal will continue; entire area will be barren.

In Target Year 25

Dredge disposal will have been completed. Approximately 1/2 of the area will be revegetated, 1/2 barren.

In Target Year 50

Three-quarters of the area will be revegetated, 1/4 will be barren.

PROJECT WITH CONDITIONS

965 Elevation with 7500 Acres
Green River SRS Site

In Target Year 1

Project conditions are the same as baseline with the exception of 5 acres of developed habitat will be lost to Disturbed Revegetated (See Table 3 for acreages covered by sediment). All timber (pole stage and older) covered by sediment will become Mudflow Forest.

In Target Year 5

All cover types not covered by sediment are the same as baseline. Approximately one-half of the acreage covered by sediment will be seeded. Amount reseeded will become Disturbed Revegetated. All timber, pole stage and older, covered by sediment will become Muflow Forest (See Table 2).

In Target Year 10

All cover types not covered by sediment will be same HSI and acreage as TY 5. One-half of Barren sediment area will be reseeded and placed in Disturbed Revegetated. All timber, pole stage and older, covered by sediment, will become Mudflow Forest.

In Target Year 25

1. All Urban area will be abandoned, though will remain in this category.

2. Grassland/Pasture will be in Forest Other Category (BL Forest #1 - HSI Value).

3. Reproduction Forest will be in Pole Stage. HSI will equal Pole Stage at baseline. Acreage will remain at Reproduction Forest for baseline.

4. Pole Forest will be reaching maturity, HSI will be Mean HSI for Mature Forest at baseline.

5. Barren areas remain as baseline Mean HSI for Barren cover type. One-half of Barren area will be seeded and moved into Disturbed Revegetated category.

6. Disturbed Revegetated will remain as baseline Mean HSI for Disturbed Revegetated; area will increase at the rate Barren areas are reduced.

7. All timber, pole stage and older, covered by sediment will become Mudflow Forest (See Table 2).

TABLE 3

Green River Site
(Elevation 965 with 7500 Acres)

Acreages (Covered by Sediment)

Class	1 yr.	5 yrs.	10 yrs.	25 yrs.	50 yrs.
Mature Forest	34	54	54	131	226
Reproduction Forest	189	294	294	772	836
Disturbed Revegetated	54	132	132	634	774
Riparian Forest	43	46	46	88	102
Pole Forest	17	53	53	176	221
Barren	241	268	268	939	908
Other Forest		15	15	100	119
Grass				41	58
Developed				5	23
TOTALS	578	862	862	2,886	3,267

In Target Year 50

1. Grassland will be Forest Other Category, Mean HSI at baseline.

2. Reproduction Forest will now be Mature Timber with Mature baseline HSI, acreage will be same, minus sediment coverage.

3. Pole Forest will be at maturity, HSI will be Mature at baseline, acreage same minus sediment coverage.

4. Barren areas remain as baseline Mean HSI for Barren cover type. One-half of Barren area will be seeded and moved into Disturbed Revegetated category.

5. Disturbed Revegetated will remain as Disturbed Revegetated; area will increase at rate Barren reduced.

6. Mature timber acreage equals baseline minus sediment coverage, HSI same as baseline.

7. All timber (pole and older) covered by sediment will become Mudflow Forest (See Table 2).

ASSUMPTIONS

In Formulating Project With - Elevation 960 with 7500 Acres

Timber Harvest Schedule

1. No timber harvest will occur, land will be purchased as is by the Federal Government.

2. No subsequent timber harvest will occur.

Natural Succession

1. In riparian areas, unstable masses, high erosion, limited seed invasion will hinder vegetation reestablishment.

2. Estimate 10 years for trees to reestablish; 100 - 150 years to mature forest. Alder, maybe Cottonwoods will be early tree species. Lupine, Devils Club are also early species (on cool mudflows). Huckleberry, Vine Maple are expected to be later plant species.

3. On hot mudflows primary succession will occur; Lupine, Fire Weed are expected to be early species. Some areas will remain barren for as long as 50 years.

Sediment Projections

At Green River:

1. Fiscal Year 85 cofferdam construction begins - 30 ft. high.

2. Will use 965 ft. pool elevation - 3,267 acres will be covered by sediment, 7,448 acres will be purchased by Federal Government at the retention structure to maintain sediment.

3. During low flow period (summer), the area will be like a dry lake with river flowing through - very similar to N - 1's condition.

4. During high flows (winter) - at dam, some pooling will occur.

5. Larger particles will fall out upstream.

6. Can expect changing braiding channels and flooding.

7. Should expect that this area will look much the same with and without project. Big differences will be in downstream channel braiding. Braiding will be reduced with the project. These differences will be reflected in LT-3 and LT-1.

8. Animals can probably walk on this area.

9. Artificial grass seeding and fertilization will occur throughout the life of the project.

At LT-1 and LT-3:

1. Sediment disposal at LT-1 and LT-3 will be an interim measure until the SRS is fully operational. LT-1 has almost reached capacity, filling will be completed here before filling is complete at LT-3.

2. Disposal material will completely cover the area in Target Year 1. Economically, this is the cheapest method for filling.

3. Artificial grass seeding and fertilization will occur throughout the disposal of sediment.

4. Disposal will be made in a way to create low areas for wetland development.

5. Tree seedlings will be planted when disposal is completed.

PROJECT WITH CONDITIONS

965 Elevation at Green River
LT-1

In Target Year 1

Entire area will be covered with dredge disposal; entire area will be barren. HSI will be Mean HSI for Barren.

In Target Year 5

Entire area will be covered with dredge disposal material. Grass will be established on one-half of the area by artificial seeding and fertilization. HSI will equal Disturbed Revegetated at baseline and Mean HSI for Barren at baseline.

In Target Year 10

Dredge disposal in the area will have been completed. Grass will be established on one-half of the area by artificial seeding and fertilization. Tree seedlings (Alder, Cottonwood, etc.) will be established on one-quarter of the area. HSI for three-quarters of the area will equal baseline. HSI for Disturbed Revegetated. Barren area HSI will equal Mean HSI for Barren at baseline.

In Target Year 25

Same as Target Year 10.

In Target Year 50

1. Grassland will cover one-quarter of the area; HSI will equal Mean Value at baseline.

2. Disturbed Revegetated will comprise one-quarter of the total area; HSI baseline Mean Value.

3. Other Forest will cover one-quarter of the area; HSI will equal Mean HSI Value at baseline.

4. Forested Wetland will comprise one-quarter of the area; HSI will equal Mean HSI Value at baseline.

PROJECT WITH CONDITIONS

965 Elevation at Green River
LT-3

In Target Year 1

Entire area will be barren. HSI values will be Mean HSI for Barren.

In Target Year 5

One-half of the area will be barren; one-half of the area will be reseeded. HSI values will equal baseline HSI values for Barren and Disturbed Revegetated.

In Target Year 10

Same as Target Year 5.

In Target Year 25

Dredge disposal in area will have been completed. Grass will be established on one-half of the area by artificial seeding and fertilization. Tree seedlings (Alder, Cottonwood, etc.) will be established on one-quarter of the area. HSI for three-quarters of the area will equal baseline HSI for Disturbed Revegetated. Barren area HSI will equal Mean HSI for Barren at baseline.

In Target Year 50

Same as LT-1.

COVER TYPES

Reproduction Forest

Managed timber under 20 feet in height.

Mature Forest

Timber greater than 60 feet in height, managed or unmanaged.

Disturbed Revegetated

Areas impacted by mudflow which are revegetating by sprouting or seeding (natural and artificial).

Barren

Minimal vegetation or completely lacking vegetation.

Pole Forest

Managed forest 20-60 feet in height, limited understory.

Riparian Forest

Arbitrarily delineated as 150 feet either side of Toutle River tributaries.

Other Forest

Broadleaf or mixed forest.

Developed

All developments including residential, logging, etc.

Forested Swamp

Palustrine, forested wetland.

Mudflow Forest

Areas affected by mudflow, timber is still standing, but dead. Understory is herbaceous or low shrubs.

STUDY NAME--MOUNT ST. HELENS

Without (PA 1) 965 El. Without 7540
With (PA 2) El. 965 With 7450 AC
Life of Project--50 Years

November 13, 1984

Evaluation Species	AAHU With	AAHU Without	AAHU Change
1. Red-tailed hawk	1,796.41	1,795.26	1.15
2. Violet green swallow	3,547.90	2,657.34	890.56
3. Common snipe	1,107.12	685.78	421.34
4. Gold-crown kinglet	2,386.34	2,377.00	9.34
5. Mallard	1,107.13	840.77	266.36
6. Ruffed grouse	2,691.14	2,681.50	9.65
7. Song sparrow	2,694.61	2,333.79	360.81
8. Bobcat	2,960.08	3,575.33	-615.23
9. Shorttail weasel	2,063.04	2,457.63	-394.59
10. Black-tailed deer	3,229.34	2,994.95	234.40
11. Roosevelt elk	2,788.49	2,961.72	-173.22
12. Beaver	1,447.28	890.04	557.23
13. Townsend chipmunk	2,341.26	2,869.52	-528.25
14. Pacific giant salama	1,309.51	1,482.90	-173.38

APPENDIX C. Estimated Costs for Specific Mitigation Measures

Instream Rehabilitation

Gabions	$18/linear foot
Modification of log jams	$4,000 - $10,000
Log sills	$180/sill
Boulder groupings	$300 - $600/group or $16/linear foot
Blasting (creating) pools	$350 - $500/pool
Modification of culverts	$2,400
O&M	$1,000/year beginning at 5th year
Gravel replacement	$30,000 - $41,600/stream
Root wad replacement	$800 - $1,500/day

Passage

Trap and haul	$1,000,000
O&M	$100,000/year
Juvenile bypass	Built into dam

Public Access

	$60,000 - $70,000/site - does not include land costs

Fish Stocking

Upstream of Green River SRS	$1,400 - $1,700 annually

Revegetation

Douglas Fir	$125/1,000 seedlings
Alder	140/1,000 seedlings
Willow - Cottonwood	125/1,000 seedlings

APPENDIX D. Listed and Proposed Endangered and Threatened Species and Candidate Species that may Occur within the Area of the Cowlitz and Toutle Rivers, Cowlitz and Lewis Counties, Washington Updated 11/15/84 (1-3-85-SP-58) Cross Reference (1-3-83-SP-85).

LISTED

Bald Eagle (*Haliaeetus leucocephalus*)

Cowlitz County

Nesting territory - T07N, R01W, Sec. 31 - 1/4 mile south of Coweeman River - nest down in 1980.

Lewis County

Nesting territory - T11N, R01E, Sec. 7-8. 11/6/81
Nesting territory - T12N, R01E, Sec. 27 inactive.
Nesting territory - T11N, R04E, Sec. 2 - inactive; inundated by Riffe Lake.
Nesting territory - T12N, R03E, Sec. 26 - inactive; two nests - nests down in 1979.
Nesting territory - T11N, R06E, Sec. 06 - inactive; two nests - nests down in 1982.
Nesting territory - T12N, R08E, Sec. 10 - inactive; nest down in 1982.
Nesting territory - T12N, R09E, Sec. 06 - inactive; nest down in 1982.
Nesting territory - T13N, R09E, Sec. 16 - inactive; nest down; area clearcut in 1981.
Nesting territory - T12N, R21E, Sec. 16 - 1 young produced - 1982.
Nesting territory - T11N, R06E, Sec. 07 - status unknown.

Wintering concentrations of eagles occur along both the Toutle and Cowlitz Rivers with highest concentrations around and below Mayfield and Riffe Lakes.

PROPOSED

None.

CANDIDATE

None

EXHIBIT 2

PUBLIC VIEWS AND RESPONSES

This exhibit contains copies of all comments received on the Draft Feasibility Report and EIS during the 45-day public review period which ended 17 December 1984, and the Corps responses to those comments. This includes written comments received as a result of the public meeting which was held in Longview, Washington on 29 November 1984. A list of the agencies, organizations and individuals who provided comments is included in this exhibit.

Comments and Corps responses are presented in two sections: 1) Letters with detailed comments which require specific, individual responses, and 2) Letters with general comments which are common to a number of other respondents. Responses to comments in the first group of letters are provided with each letter; the second group of comments is responded to in summary format in the following paragraphs. In this summary, similar comments from different sources are consolidated into a single paraphrased comment. These comments generally express support for the preferred plan, opposition to local cost-sharing, or opposition to the preferred plan. The Corps response immediately follows each comment.

SUMMARIZED COMMENTS AND RESPONSES:

1. Comment: We wish to express our support for implementation of the preferred plan consisting of a sediment retention structure on the North Fork Toutle River at the Green River site along with downstream measures to remove sediment from the Lower Toutle, Cowlitz, and Columbia Rivers.

Response: Thank you for expressing your views on this plan. Your views will be considered in reaching a final decision on a sediment control solution for Mount St. Helens.

2. Comment: We object to the proposal that local and state governments share in the cost of construction of this project.

Response: Thank you for expressing your views on this plan. Your views will be included in the official record which will be provided to Administration officials for their consideration in developing their recommendations to Congress for project authorization and funding.

3. Comment: We are opposed to construction of a sediment retention structure on the Toutle River. Please consider other alternatives to achieve sediment control.

Response: We have considered many sediment control alternatives, including alternative measures and alternative locations for their implementation. We have outlined the process of identifying and screening these alternatives in the Feasibility Report. It is our conclusion based upon existing information that the preferred plan consisting of a sediment retention structure on the North Fork Toutle River combined with downstream measures is the most efficient and cost effective solution to the sediment control problem. However, we are continuing to monitor sediment erosion and if a significant change occurs, we will re-evaluate the preferred plan. We thank you for expressing your views. Your views will be included in the official record which will be provided to Administration officials for their consideration in developing their recommendations to Congress for project authorization and funding.

Comments on the Draft Feasibility Report and EIS were received from:

U.S. Environmental Protection Agency
U.S. Department of Interior
U.S. Department of Commerce - National Marine Fisheries Service
U.S. Department of Health and Human Services
U.S. Department of Transportation - Federal Highway Administration
Washington Governor John Spellman
State of Washington Department of Fisheries
State of Washington Office of Archaeology and Historic Preservation
State of Washington Department of Game
State of Washington Department of Social and Health Services
Cowlitz County
Cowlitz - Wahkiakum Governmental Conference
City of Castle Rock
City of Longview
City of Vancouver
Local Government Consensus (43 Entities)
Port of Kalama
Port of Longview
Port of Vancouver
Port of Walla Walla
Longview Public Schools
Beacon Hill Sewer District
Consolidated Diking Improvement District No. 1
Cowlitz Economic Development Council
Longview Chamber of Commerce
Willapa Hills Audubon Society
Longview Fiber Company
Weyerhaeuser Company
Quoidbach Construction Company
Richard and Joan O'Neill
Muriel Gulickson
Doris & David Deschacht
Ralph & Ferne Uining
Arnold Olson
Harvey & Betty Anne Cliffton
O. G. Woolridge
Penelope Harvey
Stephen Wargo
Mr. & Mrs. A. W. Mott
Gordon Kerr
Elaine Bradford
Mr. & Mrs. L. S. Peru
Mr. & Mrs. Dale Kodad
Jack Harper
Sally Harper
Marshall Black
Harry Larsen
Elaine Larsen
Glen Milhise
Phil Hill
Benny Hill
C. R. Ruff

Hank Suny
Kathy Hammer
Larry Ruis
James Nunn
John Shaw
Donald Binion
Joseph Gallon
Terry Herndon
Brian Greenwood
Patrick Schmitt
Greg Drew
Albert Wiest
William Weiss
Alden Jones
Roy Hollister
Peter Meyer
Gail Todd
Mabel Stewart
Lois Hartwell
Shirley Dalsgard
C. A. Rolfe
Grace A. Rolfe
Janet Hicks
M. Studeman
Roland & Morita Lyons
Margaret Gudgel
Mrs. E. H. Peterson
Mr. & Mrs. W. A. Kemper
Mrs. A. J. Larsen
J. Koplis
Elba Saffel
Robert & Selma Bricknell
Frank & Hope Taylor
Mabel Kent
Daisy Turner
Mr. & Mrs. C. E. Whittle
Mary Pease
Joe & Martha Merly
Irene Hart
Hariett McDaniel
Dorothy Franck
Mr. & Mrs. Jeffery L. Davis
Teresa Bombardier
John & Hazel Ericksen
Nancy & Sam Boyd
Jim & Kathy Mauck
Jim Fletcher
W. K. Lacey
Frank Swideroki
Mrs. Helen Maier
Carl H. Dunning
Robert & Erma Fristad
Mrs. Genevieve Mayo
Mr. & Mrs. Burl Gilpin

Paula & Bob Bartell
William & Esther King
Donna Rolfe
Stanley G. Hooper
Malcolm Worrell
Robert N. Vaught
Mary R. Springer
Mr. & Mrs. R. A. Ainslie
Beverly Bright
Bert Lake
Don Manasio
Patricia Nicholson
Mrs. Lillian Bundy
W. G. Presnell
Zoltan Kosa
Michael & Joyce Coffey
Karl O. Jonasson
Alan W. Goofrey
Mr. & Mrs. Leo Walstead
Carolyn Shelton
Lee Culkins
Ray Ryan Bernice L. Mackey
Linine F. Randolph
Frank J. Saryz
Michele V. Bogdon
Robin Schwalm
Douglas G. Noakes

55-487 O - 86 - 23

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

REPLY TO ATTN OF: MS 423

DEC 13 1984

Colonel Robert L. Friedenwald
District Engineer
Portland District Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

RE: Mount St. Helens, Washington: Feasibility Report and Draft Environmental Impact Statement

Dear Colonel Friedenwald:

We have reviewed the referenced document concerning a long-term solution to the sedimentation and flooding problems caused by erosion of the debris avalanche near Mount St. Helens, Washington. We offer the attached comments to assist you in preparing the final Environmental Impact Statement (EIS).

Our review indicates there are two important unresolved mitigation issues associated with construction of the preferred alternative (the Single Retention Structure at the Green River site on the North Fork Toutle River). These are: (1) provision for adequate anadromous fish passage facilities at the proposed dam, and (2) avoidance of, or mitigation for, the use of wetlands near the mouth of the Cowlitz River for the deposition of dredged sediments.

We support the inclusion of a fish passage component as a part of the preferred alternative. Due to the uncertainty of establishing a successful anadromous fish passage program, we recommend alternative mitigation measures be incorporated into the project to assure restoration of this important resource. Such measures might include a commitment to restore fish runs and/or habitat in other areas within the Toutle/Cowlitz River drainages.

We were disappointed by the lack of discussion of alternative strategies for dredged material disposal at the mouth of the Cowlitz River. This activity is a part of this project and should be included in the EIS. We fully support the recommendations of the U.S. Fish and Wildlife Service (final draft Coordination Act Report, December, 1984) relative to this issue. Based upon that report and the evidence presented by the Corps in Appendix D, it appears to be possible to avoid impacting wetlands and high value riparian habitats adjacent to the Cowlitz and Columbia Rivers. For those areas that are impacted, mitigation must be provided. We recommend the Corps, EPA and appropriate resource agencies convene a task force immediately to prioritize disposal sites and establish mitigation requirements. Funding for this mitigation, as with all mitigation efforts associated with this project, should be made a part of the project cost (i.e., they should be funded by Congress and implemented by the Corps).

The selection of an appropriate strategy for handling the sedimentation problem depends primarily on estimates of debris avalanche erosion rates. Appendix C contains information which indicates there is a great uncertainty associated with making such estimates. We support the Corps commitment to use continually updated sediment erosion data in making decisions on alternatives. If future data demonstrate a lower than expected rate of sedimentation, consideration must be given to effective alternative strategies which are less costly (e.g., the use of Sediment Stabilization Basins or the construction of a lower Single Retention Structure).

According to our rating system for EISs, we have rated this document EC-2, which means that EPA has environmental concerns with the implementation of the preferred alternative and we feel the EIS contains insufficient information to fully assess environmental impacts that should be avoided in order to fully protect the environment.

If you have any questions concerning our comments, please contact Mr. Gary Voerman of my staff at FTS 399-1448.

Sincerely,

Ernesta B. Barnes
Ernesta B. Barnes
Regional Administrator

Attachment

cc: USFWS-Portland
USFWS-Olympia
NMFS
WDE
WDG
WDF

Detailed Comments

(1) The environmental issue of primary concern to EPA is the impacts associated with the use of wetland areas near the mouth of the Cowlitz for the deposition of dredged material. Part of the difficulty in addressing this issue stems from the multitude of documents identifying potential disposal sites and estimating dredged material volumes. For purposes of this analysis we have used the Fish and Wildlife Coordination Act Report (final draft, December, 1984), the Cowlitz-Toutle Watershed Management Plan (1983), and Appendix D, Exhibit 5 (Analysis of Potential Dredge Disposal Sites). This illustrates the need for a definitive comprehensive evaluation of disposal site options. This would be one task of the proposed dredged disposal task force to be formed in the near future.

1 From information in the referenced documents it appears feasible for the Corps to follow the U.S. Fish and Wildlife Service Coordination Act Report recommendations concerning disposal sites. For the preferred alternative (177 foot-high Sediment Retention Structure-Green River Site). Sediment from the Cowlitz River sumps can all be placed in areas identified as not requiring mitigation. By our calculations, such areas have much more than the fifteen million cubic yard (mcy) capacity required over the life of the project. In fact, according to the maps provided in Appendix D, Exhibit 5, Cottonwood Island alone could accomodate the 71 mcy of sediment projected for the no action alternative. Basically, we see no reason to use valuable wetland areas for the disposal of Mount St. Helens sediments.

A full and accurate analysis of dredged material disposal options should be included in the EIS. Such an analysis must encompass other disposal areas, such as those identified on pages 39-41 of the Fish and Wildlife Coordination Act Report. There is no justification provided by the Corps for limiting consideration of disposal sites to those two miles or less from the Cowlitz sump. Additionally, the capacity of all sites would be increased substantially if the fill reaches 70 feet CRD as proposed. In-water (maintenance channel) disposal of dredged material must also be evaluated as an option which minimizes adverse impacts to wetland habitats.

2 (2) EPA supports all of the recommendations contained in the December 1984, U.S. Fish and Wildlife Coordination Act Report prepared for this project.

3 (3) While the EIS (pg IX-I) incorporates all attachments by general reference, the usefulness of this document to decisionmakers would be enhanced substantially if specific pages were referenced and if important data and conclusions were summarized. The Fish and Wildlife Coordination Act Report and Appendix D both contain information which should be summarized or specifically referenced in the text of the EIS.

4 (4) The details and problems associated with the fish passage mitigation plan should be more thoroughly discussed in the EIS. Such a discussion is found on pages D-121-123. If the problems associated with trapping and hauling adults and passing fingerlings through the regulated outlet structure cannot be overcome, what alternative mitigation measures will the Corps be committed to implement?

5 (5) Pg. IX-4; the EIS should document what further studies were conducted to justify the statement that several fish and wildlife mitigation measures were "neither justifiable or appropriate for inclusion with this project."

6 (6) We agree with the statement concerning the need for additional environmental assessment of impacts associated with dredging and disposal activities (pg. IX-II). Where feasible, such assessments should be made a part of the EIS. If these assessments indicate wetland impacts, we will require mitigation consistent with NEPA and the 404(b)(1) Guidelines.

7 (7) The "Comparative Effects of Alternative Plans" chart (pg. IX-13-20) should contain more specific information to allow a reasoned judgement on comparative impacts. Specifically, a quantification of impacts associated with each of the alternatives would be useful. Generalized statements concerning sedimentation and fish and wildlife benefits are not useful for meaningful alternatives comparisons. The information necessary for this modification is contained in the various attachments to the EIS.

8 (8) In light of the above discussions on dredged material disposal sites, the basis for the statement (pg. IX-26) that limited area for disposal "will soon result in filling valuable wildlife habitat" should be articulated in the EIS. We believe valuable wildlife habitat can be avoided by careful planning.

9 (9) Previous planning efforts have resulted in the selection and use of several specific sites for dredged material disposal (pg. IX-33). These sites that have been and are being used should be identified in the EIS along with those sites proposed for use. The environmental impacts associated with a variety of disposal alternatives should also be evaluated in the EIS.

10 (10) The amount of dredged material removed by the Sediment Stabilization Basin alternative should be included in the EIS (pg. IX-34). In conjunction with this alternative, the amount of dredging required in the Cowlitz and Columbia Rivers should be calculated along with the acres and types of habitats expected to be impacted.

11 (11) The water quality impacts of all alternatives are not discussed in sufficient detail for a comparison to be made (pg. IX-31-36). In addition, the information on adverse water quality impacts associated with the Stilling Basins (pg D-20-21) should be included in the EIS. What impacts will algae blooms, bacteria and potential dissolved oxygen depletions in the Stilling Basin have on fisheries and public health?

12 (12) The basis for the statement that erosion of mudflow deposits would continue below the sediment retention structure for only two years should be explained in the EIS. This statement seems inconsistent with the contention that sediments will accumulate in the Cowlitz and Columbia in substantial quantities up to five years after project initiation.

13 (13) The statement (pg. IX-38-39) that lack of environmentally sound disposal sites will require the use of upland sites providing "valuable detrital imput" and inwater sites in locations that provide "valuable fish rearing areas" ignores Corps plans to fill valuable wetland areas (which have values for detrital imput as well as for fish and wildlife). Locations, acreages and values of these sites should be included in the EIS.

14 (14) pg. IX-40: How would fisheries be affected in the Sediment Stabilization Basin alternative compared to the Base Condition? How much reduced sedimentation would occur in the Cowlitz and Columbia as a result of implementation of the SSB alternative?

15 (15) The discussion of water quality (pg. IX-42-43) should include the information provided in D-20-21.

16 (16) Pg. IX-43; Please identify the "productive rearing habitat" that must be filled in the Columbia River under the No Action alternative.

17 (17) The statement (pg. IX-44) on the lack of environmentally acceptable disposal sites and the loss of hundreds of acres of valuable wildlife habitat at the mouth of the Cowlitz under the No Action alternative should be supported. As stated above; we feel that insufficient information exists to make such a statement and that the Corps site capacity figures in Appendix D contradict this contention. We do recognize that the preferred alternative would substantially reduce the need for Cowlitz Sump dredging and would have the environmental benefit of reduced impacts on all downstream habitats. The exact nature of that benefit has not yet been determined.

18 (18) Pg. IX-46; The types and acres of habitat impacted under the Base Condition should be summarized in the EIS (note habitat maps in the Fish and Wildlife Service Coordination Act Report). How much reduced sediment load to the Columbia River will result from this alternative.

19 (19) How does limited Permanent Evacuation differ from the Base Condition such that it results in different wildlife impacts? It would be best to summarize all adverse environmental impacts for each alternative The summary should highlight those impacts associated only with the alternative under discussion to avoid the misleading suggestion that one alternative has unique impacts that are, in fact, held in common with other alternatives.

20 (20) Pg. IX-47; How much sediment reduction in the Columbia River will result from the implementation of the Sediment Stabilization Basin Alternative?

21 (21) Pg. IX-48; How much reduction in Columbia River sedimentatin would result from the implementation of the Multiple Retention Structure Alternative? What acreages and types of habitat behind the structures would be affected by this alternative?

22 (22) Pg IX-48; How many acres of wetlands/riparian habitat will be created behind the single retention structure over the project lifetime?

23 (23) Pg IX-66: Appropriate steps to minimize potential adverse effects on the aquatic ecosystem include efforts to avoid or mitigate for downstream impacts associated with dredging. In addition to the fish passage mitigation commitment, we recommend the Corps agree to avoid wetland habitats where feasible and mitigate for any such habitats adversely impacted by dredged material disposal.

24 (24) We support the statement (pg. X-5) concerning the use of updated sediment data in CP&E studies. If significant reduction on sediment estimates result from new data, other alternatives may become preferable from both an economic and environmental standpoint.

Responses to EPA Comments:

1. *Dredging at the mouth of the Cowlitz River would prevent sediment from entering the Columbia River navigation channel, and is therefore a maintenance activity associated with that channel project.* While Columbia River dredging is discussed in this feasibility report to provide a comprehensive evaluation of impacts, no specific authorization or funding is requested in this report for actions necessary to maintain this navigable waterway nor is dredging and dredged material disposal at the mouth of the Cowlitz a part of the preferred plan addressed in this report. Authority is already provided under P.L. 87-874 for actions pertaining to federal maintenance of the Columbia River navigation channel. Evaluation of the effects of dredged material disposal associated with maintenance of this channel are separate from this report and would be accomplished under that authority. We support the proposal to form a task force, under this authority, to address disposal activities for this area.

2. Comment noted.

3. Comment noted. The referenced documents were used in preparing this Environmental Impact Statement.

4. Developing specific plans and specifications for fish passage facilities, as well as the main dam, will be accomplished during the Continued Planning and Engineering (CP&E) stage. If it is determined that the fish passage facilities are inadequate, studies would be initiated to develop and, if justified, to construct new improved fish passage facilities or other mitigative features.

5. U.S. Fish and Wildlife Service modified their recommendations in their final Coordination Act Report. Our responses to the recommendations of the final report may be found in Exhibit 1.

6. As stated in the EIS (P. IX-11), the information available at this time relating to the need for and the location of dredging and disposal is insufficient to clearly define the timing and extent of dredging and disposal activities. Columbia River dredging and disposal requirements will be addressed as part of normal navigation channel maintenance coordination.

7. As you note, the table of comparative effects summarizes the highly detailed information contained in other sections of the main report and appendixes. Expansion of this table to include this more detailed data would create an unwieldy assemblage of information. The table serves the purpose of demonstrating the relative impacts of the various alternatives so that the reader can better organize, in his or her own mind, the information contained throughout the report.

8. To the extent practicable, we hope to avoid impacting valuable wildlife habitat through careful planning. We have proposed establishing a task force to address dredged material disposal. The statement you have referenced, however, reflects the magnitude of material that may require disposal under our worst-case analysis.

9. Please refer to Responses 1 and 6.

10. This alternative was addressed in the Comprehensive Plan but screened from further detailed evaluation in the Feasibility Report. Please refer to page V-9 of the Comprehensive Plan for this detailed analysis.

11. Information on the water quality effects associated with the stilling basins has been added to the EIS. Other water quality effects of the preferred plan will continue to be evaluated during the CP&E stage.

12. The EIS has been revised to clarify this point. The statement on p. IX-36 of the Draft EIS that "erosion of mudflow deposits would continue for two years" has been changed to "dredging in the Lower Toutle River would continue to be required for two years."

13. Please refer to Response 1 and 6.

14. Please refer to Response 10.

15. This information has been added to the EIS.

16. The statement you have referenced reflects the magnitude of material that may require disposal under our worst-case analysis for the no-action alternative. Under the no-action alternative, emergency dredging may be required to maintain the navigation channel. Such emergency operations would require the use of the most expedient disposal sites, which could include productive rearing habitat.

17. The statement you have referenced has been clarified to read "The lack of environmentally acceptable disposal sites at the mouth of the Cowlitz to contain all material requiring dredging under this alternative will require the use of some areas of high wildlife value; wildlife losses associated with the loss of riparian and wetland habitats with this alternative could be significant." The volumes you have referenced in Appendix D were calculated to show maximum potential disposal, not probable, disposal. The volumes shown in Appendix D were calculated using heights of 70 feet and slopes of 1V on 4H.

18. The majority of the maps shown in the CAR were prepared by Portland District for the habitat-based evaluations conducted for this study. Since the CAR is an exhibit to the main report, and to reduce redundancy and length, they were not included in the EIS. The projected Columbia River dredging requirements for the no-action condition during the 50-year project life is 145 mcy. With the base condition, this requirement is reduced to 71 mcy (see Chapter II).

19. The Limited Permanent Evacuation alternative includes the removal of structures from the flood-prone areas upstream of the leveed areas of Kelso and Longview. Sediment would be allowed to accumulate in these areas and to naturally revegetate, eventually creating wildlife habitat where urban development had existed before. The base condition does not provide for the removal of structures and would not result in a similar creation of wildlife habitat.

20. Please refer to Response 10.

21. This alternative was addressed in the Comprehensive Plan but screened from further detailed evaluation in the Feasibility Report. Please refer to pages V-11 to V-14 of the Comprehensive Plan for this detailed analysis.

22. Once the maximum sediment retention has been accomplished, a broad plateau would remain behind the single retention structure. Riparian and wetland habitats would develop in this area through natural revegetation. The number of acres of each of these types of habitats would be difficult to estimate with certainty at this time.

23. Any effects on wetland habitats which might occur would result from dredging at the mouth of the Cowlitz, which would be done as part of the maintenance dredging for the Columbia River navigation channel. Assessment of the effects on wetlands, as well as any potential mitigation, would be accomplished under that authority.

24. Comment noted.

United States Department of the Interior
OFFICE OF THE SECRETARY
PACIFIC NORTHWEST REGION
500 N.E. Multnomah Street, Suite 1692, Portland, Oregon 97232

December 20, 1984

84/1393

Colonel R. L. Friedenwald
District Engineer, Portland District
U.S. Army Corps of Engineers
P. O. Box 2946 Portland, Oregon 97208

Dear Colonel Friedenwald:

The Department of the Interior has reviewed the Draft Feasibility Report and Environmental Impact Statement (EIS) for Mount St. Helens, Cowlitz County, Washington. The following comments are provided for your use and consideration when preparing the final document.

General Comments

1 The Department of the Interior believes that the draft EIS omits needed information and is deficient in several areas that are essential to a clear understanding of the environmental impacts that would occur as a result of implementing the preferred plan. In most instances, fish and wildlife impacts of the preferred plan are not clearly identified or quantified. In some cases, impacts are understated or absent from the discussion. Instead the draft EIS provides a general analysis of the relative impacts of the various alternatives addressed in the Corps of Engineers (Corps) November 1984 comprehensive plan for responding to the long-term threat created by the eruption of Mount St. Helens, Washington. Information on the preferred plan is no more detailed than that provided for any of the other alternatives, yet the draft EIS is accompanied by a draft feasibility report that will be used to recommend Congressional authorization and funding for construction of a specific plan.

The Fish and Wildlife Service (FWS) has prepared a Fish and Wildlife Coordination Act Report (CAR) addressing the impacts of the project on fish and wildlife resources. The report identifies important mitigation measures to prevent or offset the impacts of the project on these resources. The draft CAR that accompanies the draft feasibility report addresses the full range of project alternatives and impacts, and the mitigation recommendations are accordingly broadranging in scope. Since then, the Corps has provided specific project information on the preferred plan to the FWS. Therefore, the final CAR will focus on the preferred plan's impacts and mitigation needs. The final CAR will become part of the final feasibility report.

The final EIS should incorporate details from the final CAR and be consistent with its findings and recommendations.

1 Finally, the draft EIS does not address the cumulative effects of the preferred plan's impacts to fish and wildlife resources, in conjunction with impacts from measures to control water levels in Spirit Lake. The impacts of the Corps' plan for a permanent outlet for Spirit Lake were addressed in an earlier EIS and separate CAR dated February 10, 1984. In its response to that report, the Corps stated that measures not appropriate for the short-term, emergency nature of the Spirit Lake work should be included in the feasibility study recommendations. A discussion of cumulative effects of Corps' activities in the Toutle River watershed and actions planned to address those effects should be provided in the final EIS.

Specific comments of the Fish and Wildlife Service
Draft Environmental Statement

2 Page IX-1, Abstract: Information, displays, and maps referred to in the main report and appendices incorporated by "reference" into the draft EIS, are notably lacking as reference material in the draft EIS.

3 Page IV-4, Unresolved Issues: It is stated that "further study" determined that several of the measures recommended by the FWS in the draft CAR were neither justifiable nor appropriate for inclusion with the project, yet no reference to the study or its findings is provided. The FWS has incorporated a number of changes into its final CAR to address the specific impacts of the preferred plan. The draft CAR had recommended mitigation actions needed to address the impacts of the full range of project alternatives. The final CAR concludes that necessary mitigation actions would be significantly reduced, though not eliminated, by selection of the preferred plan. To the extent the Corps' EIS is compatible with the findings of the final CAR, there should be no unresolved issues.

4 Page IX-6, Alternatives: The abstract and summary sections identify a "preferred alternative" at the Green River site, including "associated actions", yet the draft EIS provides no further discussion or analysis of a preferred plan. The general relative analysis of alternative SRS locations and sizes, in comparison with other alternatives, does not provide the reader with a specific understanding of the preferred plan features or impacts.

5 Page IX-16, Comparative Effects: It is unlikely there would be a reduction in turbidity with the SRS because they are designed only to retain coarser materials. The fine materials (clays and silts) are easily eroded and transported and would remain in suspension (see page IX-22).

6 Page IX-36, SRS: There is no reference or documentation supporting the "greatly increased rate" of physical and biological recovery of the lower river that is assumed to occur compared to the no action conditions. What supporting information is available in the feasibility report or Appendices? In addressing downstream erosion rates below SRS (Appendix "D", Page D-37), it is stated that downstream degradation was assumed to be equal to the Toutle River erosion under the no action conditions. This statement and the assumption of "greatly increased rate" of recovery seem to be contradictory.

7 Page IX-49, Columbia: There is no reference or documentation supporting the assumed benefits of reducing wildlife impacts to the Columbia. It is stated that disposal would be limited to 15 mcy but there is no detailed disposal plan nor any quantification of disposal impacts on wildlife habitat. These items should be discussed in detail.

8 Page IX-60, Section 404(b) Evaluation: The need to dredge and dispose of 15 mcy of material in the Columbia with the SRS alternatives is stated throughout the feasibility report and draft EIS (see above comment). However, there is no discussion at all of fish and wildlife impacts associated with dredging and dredge spoil disposal in either the draft EIS or the Section 404(b) evaluation. Dredging and disposal of material in the Cowlitz and Columbia Rivers to maintain the navigation channel and to provide interim flood protection as authorized by Public Law 98-63, has had significant adverse impacts on wetland resources. On several occasions the FWS has recommended to the Corps that plans be developed and implemented to mitigate for these impacts but no action has yet been taken. The disposal of 15 mcy in this area with the preferred plan has the same potential to have serious wetland impacts. The apparent disregard of these impacts in both the draft EIS and Section 404(b) evaluation is not compatible with either the spirit or the intent of the Clean Water Act and is of grave concern to the FWS.

DRAFT FEASIBILITY REPORT

General Comments

9 The FWS does not agree with the frequent reference in the report that imply that fish and wildlife issues are addressed fully in the draft EIS. Information regarding project impacts and recommended mitigation actions has been provided to the Corps by the FWS in a revised Fish and Wildlife CAR. Information contained in that report should be incorporated in the EIS and the final feasibility report to ensure that fish and wildlife issues are fully addressed and incorporated in project plans.

Specific Comments

10 Page VII-4: The draft feasibility report indicates that project sponsors should pay the cost of most mitigation measures. While it may be appropriate for local sponsors to share the cost of project mitigation, the Corps must recognize that it is their full responsibility to ensure that project construction and mitigation are accomplished in accordance with Federal environmental policy and legislation. This requires the recognition of project impacts, reducing impacts through selection of least damaging alternatives where possible, mitigating for remaining impacts, and monitoring of project and mitigation actions to ensure they function as planned.

Appendix D, Exhibit 5: This exhibit in the feasibility report contains an analysis of potential dredge disposal sites in the Cowlitz and Columbia Rivers. Unfortunately, the criteria used to select these sites do not include any environmental considerations. Disposal material dredged from the Cowlitz sump and the general vicinity of the confluence of the Cowlitz and Columbia Rivers has been of great concern to State and Federal resource agencies. The agencies have been eager to work with the Corps in designation of sites and developing mitigation measures where required. The feasibility report presented an excellent opportunity to discuss both short- and long-term disposal plans. In view of the above, we suggest the final report include environmental impacts as a criteria for potential site selection.

Exhibit 1, Fish and Wildlife Coordination: This section contains the Corps' responses to recommendations made in the FWS's draft CAR. A number of recommendations have been deleted or changed significantly so the responses are no longer appropriate. In addition, a number of issues have been resolved or modified to a satisfactory degree. Comments on the remaining responses are as follows:

General Response: This response includes a statement that FWS recommendations do not clearly identify whether the action provides mitigation or enhancement. Actually, all of the recommendations in the draft CAR would provide mitigation only.

Response 3, Page 3: It is acknowledged that the recommendation was very broad, but this was necessary because of the numerous alternatives considered in the early feasibility study phase. Monitoring studies recommended in the final CAR apply directly to project-related mitigation
10 aspects.

Response 5, Page 3: The FWS does not agree that bypass at Green River SRS is the primary mitigation need since stream habitat improvement, wetland protection, revegetation, etc. would also be necessary to mitigate for project impacts. The final feasibility report should address all of the major mitigation recommendations and provide for modification if warranted.

Response 7 through 12, Pages 3 and 4: We believe it is the Corps' responsibility to ensure that mitigation is planned and implemented prior to or concurrently with project construction. Further, funding of these actions should be a project responsibility.

Specific Recommendations - Toutle

Response 1, Page 5: The FWS does not concur with the Corps' decision that the State be responsible for all costs associated with operation and maintenance of mitigation features. Mitigation should be considered a project expense and funded accordingly.

Response 4, Page 6: The recommendation for a fish hatchery has been withdrawn and the Corps has agreed to the development of rearing ponds.

Response 5 and 6, Pages 6 and 7: The FWS does not concur with the Corps' conclusions that these recommendations would provide enhancement. As stated elsewhere, the FWS has not recommended any enhancement actions.

Response 7, Page 7: The plan referred to in Recommendation 7 is to coordinate mitigation actions associated with the SRS only, not a basin-wide plan.

10 Response 10, Page 9: The measures referred to are mitigation only. No enhancement would result if actions are implemented.

FWS Summary Comments

11 As indicated in the foregoing comments, the FWS believes there are several areas that should be more fully addressed in the final EIS. In particular, more emphasis should be placed on specifying and quantifying impacts to fish and wildlife resources that would occur with the preferred plan. The need for adequate mitigation as provided in the final CAR should be discussed and incorporated into the final EIS. The final EIS should also address cumulative impacts of the Corps actions in the watershed, and the impacts to and mitigation needs for wetland habitats affected by disposal of dredged material.

For further assistance in these fish and wildlife matters, please contact:

Field Supervisor
U.S. Fish and Wildlife Service
727 N.E. 24th Avenue
Portland, Oregon 97232
Phone: (503) 231-6179
FTS 429-6179

Specific Concerns of the Geological Survey

The Corps' Mount St. Helens, Washington, Feasibility Report assembles an impressive body of information on the complex long-term sediment management problems posed by Mount St. Helens. The Corps has recommended a solution compatible with our present state of knowledge and flexible enough to respond to the results of continuing scientific investigation. We agree with the assessment that under normal hydrologic conditions the sediment management problems associated with the Toutle and Cowlitz Rivers are less acute but more persistent than the initial assessments presented in the Toutle-Cowlitz Watershed Management Plan and the Corps' original comprehensive plan for responding to the long-term threat created by the eruption of Mount St. Helens, Washington. We are particularly pleased to see increased attention focused on the potential sediment volume associated with individual mudflow and extreme flood events. The occurrence of such events could well cause problems during the construction phase of the proposed sediment retention structure.

12 The Corps should caution the public that certain phenomena critical to the long-term sediment management strategy are still incompletely understood by scientists monitoring the volcano. These phenomena are: (1) future eruptive activity of Mount St. Helens; (2) transport of poorly sorted, course-grained sediment in steep channels; and (3) generation of mud and debris flows by volcanic and nonvolcanic processes.

Uncertainties about the number, type, and magnitude of future eruptions will persist for the long term, but the research and monitoring now in progress at Mount St. Helens should improve the U.S. Geological Survey's (USGS) predictive capabilities in a time frame which will allow for short-term operational decisions.

The lingering uncertainties about sediment transport and mud and debris flow generation are the subjects of intensive investigations by the USGS at Mount St. Helens and by many scientific and engineering colleagues working in the Pacific Rim Steeplands. Breakthroughs that will permit more realistic simulation of erosion of the North Fork Toutle debris avalanche and downstream sediment transport are likely over the next several years. Until that time, some divergent opinions will likely persist concerning precise erosion problems, sediment sorting and armoring processes, rates of sediment transport, and downstream channel adjustments.

These comments are not meant to imply that action should be withheld pending research results. Major sedimentation-induced flood hazards exist now and will only worsen if not addressed promptly. We only wish to emphasize the desirability of maintaining flexibility to allow for an appropriate response to future increases in scientific knowledge.

13 We believe that the feasibility report may not give appropriate consideration to future channel incision on the North Fork Toutle debris avalanche deposit and downstream transport of the larger-than-2 mm-size fraction. As a result, we believe that sediment volumes in the Corps' 1985-2035 sediment budget are conservative. The Corps' computations appear to reflect an extrapolation of erosion rates observed over the last years--a period without any major regional storms.

The feasibility report assumes that the three large avalanche-impounded lakes are stable (p. IV-27, par. 2) and that a breaching-induced mudflow is not possible. Breaching scenarios other than overtopping are possible, however. Erosion over the 50-year project life could adversely affect the stability of these lakes. For example, mass failure could occur during a seismic event superposed upon seasonally high water tables in the blockages. Periodic assessment of the lake impoundment stability is clearly warranted.

A recently completed investigation of pre-1980 volcanic mudflow deposits along the Toutle River suggests that the frequency of mudflows large enough to inundate the flood plain at the confluence of the North and South Forks of the Toutle River may have occurred more frequently than indicated in published reports. At least 30 such flows have occurred over the last 4,500 years. These flows tend to be clustered during eruptive periods similar to the present activity at Mount St. Helens.

The feasibility report emphasizes the gradual degassing of the dacite magma feeding the dome, and implies a declining probability of explosively generated mudflows. However, the dome, as it continues to grow, may become unstable and collapse forming "block-and-ash pyroclastic flow capable of rapidly melting large amounts of snow. Relatively small explosions and avalanches from the dome during the late winter and spring 1982-84 have generated a variety of mudflows. Numerous flows comparable

to those of March 19, 1982, and May 4, 1984, should be expected over the project life. Also scenarios that would generate mudflows larger than the two individual flows that comprise the Corps' design mudflow are not unreasonable.

Designing the sediment retention structure in a manner that allows for rapid drawdown of the sediment-trapping pool and for addition of future storage increments would help deal with the uncertainties concerning long-term erosion volumes and the magnitude and frequency of future mudflows. It is particularly important for the retention structure to be able to absorb a major mudflow without displacing a pool of water that could cause major downstream flooding.

During the design phase, the USGS will continue to transmit to the Corps all data and research findings that are germane to the effective mitigation of volcanic and hydrologic hazards associated with Mount St. Helens.

Thank you for the opportunity to comment on this document.

Sincerely,

Charles S. Polityka
Regional Environmental Officer

Responses to Department of Interior Comments:

1. To minimize the repetition of information, the final Coordination Act Report has been incorporated into the final Environmental Impact Statement by reference, in accordance with Council of Environmental Quality regulations. Please see Exhibit 1. All the information you have provided regarding fish and wildlife impacts in your Coordination Act Report is, therefore, part of the EIS. Regarding Spirit Lake, we assume the recommendations in your Coordination Act Report address your concerns.

2. As provided for by Council of Environmental Quality regulations, we have incorporated certain information by reference so that this information need not be duplicated in the EIS.

3. The issues referred to have been deleted from the unresolved issues discussion.

4. The alternatives chapter has been revised to more clearly identify the preferred plan.

5. Turbidity can be equated to quantity of suspended sediments, and the SRS will very effectively reduce the amount of suspended sediments downstream of the structure compared to the no-action alternative. In addition, our studies of trapping efficiency ratios versus discharge rates indicate that smaller particulates (silts) will be trapped at higher flows.

6. The assumption that you have referenced was used to facilitate and simplify our early analysis of this problem; this was stated as a preface to the statement you quote. The statement that rapid downstream physical and biological recovery will occur is a conclusion based upon the reduction of sediment transport and erosion which would occur with the SRS but not with the no action alternative. In previous coordination with your staff, we have discussed the change from a sand-bedded stream below the SRS that will occur when sediment input is reduced; the information provided in Appendix C and D support these conclusions.

7. Refer to EPA response #1.

8. Refer to EPA response #1.

9. Please refer to response #1.

10. Please refer to the Corps responses to the revised Coordination Act Recommendations provided by FWS in exhibit 1.

11. Thank you for your comments on this study. We will continue to coordinate and consult with your agency as planning progresses on this project.

12. The Feasibility Report contains several cautions such as those recommended.

13. To the extent that existing data will allow, the Feasibility Report does account for incision of the North Fork Toutle River, downstream transport of gravel, and storm impacts. These will be reviewed during CP&E sediment studies.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
ENVIRONMENTAL & TECHNICAL SERVICES DIVISION
847 NE 19th AVENUE, SUITE 350
PORTLAND, OREGON 97232 2279
(503) 230-5400

December 12, 1984 F/NWR5

RECEIVED
DEC 14 1984
REGULATORY FUNCTIONS BR.

Colonel Robert L. Friedenwald
District Engineer, Portland District
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Colonel Friedenwald:

Thank you for providing the National Marine Fisheries Service (NMFS) the opportunity to review and comment on the "Mount St. Helens, Washington Feasibility Report and Draft Environmental Impact Statement." We reviewed the draft reports and offer the following comments for your consideration in preparing the final reports.

The NMFS is responsible for the preservation and enhancement of anadromous fish resources and the habitats that protect these resources. As described in the EIS, fall and spring chinook salmon, coho salmon, winter and summer steelhead trout and searun cutthroat trout utilized the Toutle River watershed prior to the eruption. Allowed sufficient time, the river is expected to gradually recover to its pre-eruption condition which would again support these fish resources. Our comments do not suggest that the No Action alternative be the preferred action plan, but are based on the premise that the resources have the potential to be restored naturally.

Considerable coordination occurred between the Corps and fish and wildlife resource agencies in identifying the resources of concern and the preferred plan to accommodate both the retention of sediments and the preservation of fish and aquatic/riparian habitats. Therefore, we confine our comments to preserving the passage of fish past the project area.

Of particular concern to this agency is the preservation of passage for both downstream and upstream migrating juvenile and adult salmonids, respectively. Juvenile fish must be able to navigate safely from their brood streams (tributaries to the North Fork Toutle River), through the sediment containment basin, and past the retaining structure. Adult fish must not be prevented from spawning in their home streams above the retaining structure.

Passage that the Corps of Engineers is proposing to develop is not identified clearly in the reports. The final reports should include a detailed description of the 1) construction, 2) operation and 3) maintenance plans for the fish passage and trapping facilities or a firm commitment by the Corps to have these plans approved by the NMFS prior to any construction activities.

Sincerely yours,

Dale R. Evans

Dale R. Evans
Division Chief

cc: Washington Dept. of Fisheries
Washington Dept. of Game
Fish and Wildlife Service, ES, Portland
Fish and Wildlife Service, Olympia

Response to NMFS Comments:

Detailed planning for a fish passage facility will be accomplished during the Continued Planning and Engineering stage of project planning. We propose to develop and plan these facilities in close cooperation with your agency.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

December 14, 1984

District Engineer
U. S. Army Engineer District, Portland
Attention: NPPPL-NR
P. O. Box 2946
Portland, Oregon 97208

Dear Sir:

We have reviewed the Draft Environmental Impact Statement (EIS) for Mount St. Helens, Toutle, Cowlitz and Columbia Rivers, Washington. We are responding on behalf of the U.S. Public Health Service and are offering the following comments for your consideration in preparing the final document.

We understand that the purpose of the EIS is to disclose the environmental impacts of alternative plans to reduce the flood threat to life, property, and transportation systems in the Lower Cowlitz and Toutle River Valleys, and to maintain navigation on the Columbia River. Alternative plans include limited permanent evacuation, sediment stabilization basins, multiple retention structures with dredging, multiple retention structures without dredging, and a single retention structure.

According to the EIS, the effects of flooding are well-known to residents of the lower Cowlitz; floods have been a recurring problem for more than 100 years. Levees have been repaired and improved after several major flood events. For these reasons, we prefer the alternative plan of limited permanent evacuation and relocation. It would provide a more permanent solution of reducing the flood threat to 5,000 people. Improved efforts also need to be made to encourage affected communities to impose land use regulations in flood plains. Therefore, the alternative measure of Land Use Regulations which involves zoning restrictions and moratoriums on construction in flood threatened areas needs to be implemented in concert with the selection of any alternative plan.

While we fully support the use of a flood warning system to minimize any loss of life in the event of major flooding, its existence still does not guarantee full protection for those residents at risk, particularly for those residents located between flood protection levees and the river. Unless the warning system is accompanied by an emergency flood evacuation program, some residents may not be benefited. Physically handicapped individuals may not hear the warning system (as presented in the EIS) or may not be able to effect self-evacuation.

2 For your information, we commented on both the Draft and Final EIS for the Alternative Strategies for a Permanent Outlet for Spirit Lake near Mount St. Helens, Washington. Please refer to our February 8, 1984 and April 25,

2 1984 comments on the Spirit Lake EIS for our concerns related to permanent evacuation and relocation of sensitive land users in the flood plain downstream of Mount St. Helens, and water supplies downstream of construction activities. Any proposed dredging and construction activities associated with the alternative plans discussed above should notify operators of any surface water supply systems (that may be affected) prior to the commencement of any work. Efforts need to be taken to insure that intake waters of any surface water supply are of suitable quality for treatment and in compliance with the National Interim Primary Drinking Water Regulations.

We appreciate the opportunity to review the Draft EIS. Please send us one copy of the Final EIS when it becomes available. Should you have any questions about our comments, please contact Mr. Robert L. Kay, Jr., of our staff at FTS 236-4161.

Sincerely yours,

Stephen Margolis

Stephen Margolis, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Center for Environmental Health

Responses to Public Health Service Comments:

1. The alternative of limited permanent evacuation was considered in the first phase of study of a sediment control solution. This alternative was dropped from further consideration and was not carried forward into the Feasibility Study. This alternative would be the most expensive to implement, and would not satisfy a primary study objective of reducing impacts to navigation in the Columbia River. The results of our public involvement program indicated little support among residents of the affected area for this alternative. As we have reported in our Feasibility Report, the preferred plan, a sediment retention structure with associated downstream actions, is the most cost-effective and efficient solution to the sediment control problem.

2. We concur with your recommendation.

State of Washington

JOHN SPELLMAN, Governor

December 13, 1984

OFFICE OF THE GOVERNOR

Col. Robert Friedenwald
U.S. Army Corps of Engineers
Portland District
P.O. Box 2946
Portland, OR 97208-2946

ATTN: NPPPL-AP

Dear Colonel Friedenwald:

Thank you for the opportunity to review the U.S. Army Corps of Engineers (COE) draft Mount St. Helens, Washington Feasibility Report and Environmental Impact Statement. I have directed the state agency task force on Mount St. Helens to review this document and respond to me with its comments and recommendations. Comment letters from these agencies are enclosed.

The state of Washington supports the COE preferred alternative of a single retention structure at the Green River site. As I stated in my December 16, 1983, letter to the President responding to the Comprehensive Plan, the traditional cost sharing formula should apply and include costs for fish and wildlife mitigation measures. Although the state is pleased that a fish trap and haul facility will be constructed, it would seem that operation and maintenance of this facility should be a Federal responsibility as it has been on other Federal projects in the state. Also, in the final Environmental Impact Statement, the state would like to see other mitigation measures considered such as monitoring and fish passage during the construction of the project. These measures are spelled out in more detail in the enclosed agency letters.

With the exception of the mitigation measures mentioned above, the cost share formula presented in the Feasibility Report is consistent with what the state has requested in the past. The state is willing to participate with the COE on this vital project and to pay its fair share under the traditional cost sharing formula. The state of Washington will begin the process to provide the necessary funds by proposing legislation for consideration by the 1985 Legislature.

Thank you again for the opportunity to respond. If you have any questions, please contact Mr. Hugh Fowler, Director, Department of Emergency Management. We look forward to working with the COE in any way in the next phases of this process, as implementation of permanent corrective measures must begin as soon as possible.

With best wishes,

Sincerely,

John Spellman
Governor

Enclosures

cc: Robert Dawson, Acting Assistant Secretary of the Army (Civil Works)
Congressional Delegation

Response to Governor Spellman's Comments:

Thank you for providing your views on this study. Our responses to comments from State of Washington agencies follow each agency letter. Your views will be included in the official record which will be provided to Administration officials for their consideration in making their recommendations to Congress for project authorization and funding.

JOHN SPELLMAN
Governor

WILLIAM R. WILKERSON
Director

STATE OF WASHINGTON

DEPARTMENT OF FISHERIES

115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

December 4, 1984

Department of Ecology
Environmental Review Section
St. Martin's Campus
Lacey, Washington 98504

Gentlemen:

U.S. Army Corps of Engineers- Mt. St. Helens, Washington Feasibility Report and Draft Environmental Impact Statement, Toutle, Cowlitz, and Columbia Rivers, WRIA E-26

1 We have reviewed the above-referenced feasibility report and Draft Environmental Impact Statement (DEIS). We feel the U.S. Corps of Engineers (Corps), given the unpredictable nature of Mt. St. Helens and the uncertainty regarding the rate and manner of sediment delivery from the existing mud flow, to downstream areas, has done an adequate job of evaluating the various alternatives to alleviate the threat of downstream flooding and disruption of navigation.

2 The Department of Fisheries will not object to the preferred alternative, a single retention structure (SRS) at the Green River site, provided the Corps fully mitigate the impacts of the project as recommended by the final U.S. Fish and Wildlife Service's Coordination Act Report (Fisheries' concurrence letter attached).

3 We are pleased that fish passage for adult and juvenile salmonids will be provided at the SRS. We are not pleased the Corps feels fish passage will mitigate for all other fish habitat impacts of their work.

4 The Corps states on Page X-2 "This Feasibility Report presents the best estimate as to the amount and timing of sediment movement under normal hydrologic events. However, not withstanding the accuracy of predicting sediment movements and other events, any program should provide the flexibility to adjust to actual conditions." They also state on Page X-1 "Continued close cooperation among federal, state and local agencies, as well as continued professional monitoring of the erosion process, will facilitate adjustments to any programmed solutions."

5 It is our position that these statements should also apply to mitigation of fishery impacts. For example, the Corps has placed heavy emphasis on the ability of the SRS to enhance the recovery of downstream habitat. While we hope this is so, we have no assurance as to what extent or in what manner recovery will occur or if recovery will be a return to usable spawning and rearing habitat for salmon.

6 We do know Alder Creek, for example, is in good fish producing condition and that the lower four miles of this stream will be negatively affected by the SRS.

7 The DEIS does not address impacts during construction such as the extensive excavation required for the foundation of the dam. It does not adequately discuss how the cofferdam will be constructed or how the fish trap and haul barrier dam will be constructed. No reference is made to maintenance of fish passage during construction.

8 We could not tell how the Corps developed its water temperature scenario for the reservoir and are not convinced a rise of six to seven degrees Fahrenheit is insignificant and will fall rapidly after passing the SRS.

9 These examples demonstrate the Corps' analysis of fishery impacts is their best estimate. Further, the Corps is committed to monitoring the mud flow and the success of their projects to achieve flood control and to assure safe navigation and is also committed to adjusting their projects as a result.

10 We feel monitoring both construction and post-project impacts is also important and prudent to insure fishery mitigation measures are successful and complete. This approach is not without precedent. The Corps' Wynoochee project is an example where mitigation for downstream passage mortality was derived through a monitoring study. Corps dredging in Grays Harbor has been monitored for fishery impacts and operations modified to reduce those impacts.

11 This is not to say we need all the answers before construction. It would not be prudent to delay this project while studies are done. It is reasonable to monitor and mitigate for impacts in a manner which will not affect the construction schedule.

12 The Corps proposes the State of Washington pay operation and maintenance (O & M) costs for fish facilities at the SRS. This proposal is unacceptable. The SRS is a Federal Project and mitigation is a Federal responsibility. Numerous projects within Washington State have fish facilities operated and maintained by the Corps including fishways on Columbia River dams, Wynoochee Dam fish facilites and the Mud Mountain Dam trap and haul facility. We feel the SRS should be operated and maintained in the same manner.

We look forward to working with the Corps and the U.S. Fish and Wildlife Service in the design and construction phase of this project to insure reasonable fish mitigation measures are implemented.

Thank you for this opportunity to comment.

Sincerely,

Duane E. Phinney for

William R. Wilkerson
Director

Attachment

Responses to Dept. of Fisheries Comments

1. Comment noted.

2. Please refer to our responses to the recommendations by the U.S. Fish and Wildlife Service, which are included with the Coordination Act Report in Exhibit 1 of the Main Report.

3. Comment noted.

4. We will continue to evaluate . h and wildlife impacts and mitigation, as well as all engineering features, .uring the Continued Planning and Engineering stage.

5. We will continue to evaluate fish and wildlife impacts and mitigation, as well as all engineering features, during the Continued Planning and Engineering stage.

6. Comment noted.

7. This study is a feasibility study, a level of study which does not result in development of project design and construction details. This information will be developed in the Continued Planning and Engineering stage.

8. This analysis was developed in accordance with generally accepted methodolgies. Details of the methods and findings can be obtained by contacting our Hydraulics and Hydrology Branch.

9. Comment noted.

10. We have responded to the need for certain monitoring activities in response to U.S. Fish and Wildlife Fish and Wildlife Service's recommendations: please refer to our responses to their recommendations.

11. Comment noted.

12. Comment noted. Our cost-sharing proposals are known in the Feasibility Report.

JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

WILLIAM R. WILKERSON
Director

December 3, 1984

Richard J. Myshak
Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 Northeast Multnomah
Portland, Oregon 97232

Dear Mr. Myshak:

Coordination Act Report - Final Draft, The Impacts on Fish and Wildlife of Proposed Sediment Control Action for the Toutle, Cowlitz and Columbia River Systems

We have reviewed your final draft Coordination Act Report (CAR) and generally agree with its contents. Your assessment of the effects of the proposed projects is adequate given the Corps of Engineers' uncertain estimates of the manner in which the sediment will be delivered from the North Fork Toutle River and the ambiguity which exists as to how the projects will affect the "recovery" of the watershed.

This most clearly demonstrates the need for general recommendations 2 - 5 which request complete monitoring of the effects of these projects during construction and after to more specifically identify mitigation measures necessary for the protection of fish and wildlife.

We concur with the remaining general recommendations as well as the specific recommendations except for Toutle River Number 6 and Cowlitz River Number 1. We do not feel the measures are necessary or feasible to implement.

Thank you for the opportunity to provide input into the earlier drafts of this CAR and to provide you with this letter of concurrence on the final report.

Sincerely,

Duane Phinney for

William R. Wilkerson
Director

cc: Keller
Mohoric
Zillges

JOHN SPELLMAN
Governor

JACOB THOMAS
Director

STATE OF WASHINGTON
OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION
111 West Twenty-first Avenue KL-11 • Olympia, Washington 98504 • (206) 753-4011

November 14, 1984

Ms. Barbara Ritchie
NEPA Coordinator
Dept. of Ecology
Mail Stop PV-11
Olympia, WA 98504

Log Reference: 584-F-COE-P-06
Re: Sediment Retention Structure
North Fork Toutle River

Dear Ms. Ritchie:

A staff review has been completed of the Mount St. Helens, Washington, Feasibility Report and Environmental Impact Statement and the technical cultural resources survey report. Based on the information provided for our review, in our opinion the proposed project will have no effect on known archaeological or historic resources included in or eligible for inclusion in the National Register of Historic Places.

Thank you for this opportunity to comment.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(206) 753-4405

dw

cc: Byron Blankenship

JOHN SPELLMAN
Governor

KAREN RAHM
Secretary

STATE OF WASHINGTON
DEPARTMENT OF SOCIAL AND HEALTH SERVICES

MEMORANDUM

TO: Barbara Ritchie, Department of Ecology
Environmental Review Section
Mail Stop PV-11

DATE: December 3, 1984

FROM: Bill Maibauer BM/JB

SUBJECT: Mount St. Helens Feasibility Report and EIS for the Sediment Retention Structure

The Water Supply and Waste Section of the Department of Social and Health Services requests that this project for the sediment retention structure be pursued as rapidly as possible. Our concerns for the public water supplies serving the residents downstream of the proposed structure have been met. Since the Mount St. Helen's explosion on May 18, 1980 these needs were met by construction of the Castle Rock - Toutle regional water system, additions to the Longview water treatment plant, and the new Kelso water treatment plant. We will push for an expeditious construction schedule for this structure.

WHM:sb

cc: Jim Hudson
Bill Liechty

JOHN SPELLMAN
Governor

DONALD W. MOOS
Director

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

M E M O R A N D U M

December 4, 1984

TO: Barbara Ritchie, Environmental Review

FROM: Gary Hanson, Southwest Regional Office GH

SUBJECT: U. S. Army Corps, Mt. St. Helens, Washington, Feasibility Report

The preferred plan, a single high dam above the confluence of the Green River, is essentially the solution that we have suggested for the sedimentation problem.

A couple of points that could be considered further are:

1. What would the impact be on this plan if a 10 - 25 year frequency flood occurred on the Toutle River before the dam is constructed?

2. What are the estimates for a gravel budget in the Toutle River downstream of the dam and how much of that gravel will be from the Green River?

The Washington Department of Ecology (WDOE) has the responsibility for administering several programs that may require permits, approvals, or review by our agency; including water rights, NPDES permits, short-term exceptions to water quality standards, and dam safety.

GH:cl(2:3)

701

Responses to Dept. of Ecology Comments:

1. We have recommended in the feasibility study that prompt action be taken to implement recommended actions since an event of large magnitude could adversely affect downstream areas.

2. Our foundation explorations show a great abundance of gravels in the Toutle River system.

JOHN SPELLMAN
Governor

FRANK LOCKARD
Director

STATE OF WASHINGTON
DEPARTMENT OF GAME
600 North Capitol Way GJ-11 • Olympia Washington 98504-0091 • (206) 753-5700

December 3, 1984

Lieutenant Colonel Jon D. Katin
Acting District Engineer, Portland District
U.S. Army Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208-2946

DRAFT ENVIRONMENTAL IMPACT STATEMENT:
Mt. St. Helens, Washington -
Feasibility Report

Dear Lieutenant Colonel Katin:

Your document was reviewed by our staff as requested; comments follow.

1 We are in overall concurrence with your feasibility report and DEIS. Your preferred alternative is clearly the least impacting proposal. Features to lessen adverse effects have been included in project design. In addition, your descriptions of impacts on fish and wildlife generally appear to be accurate.

However, important areas of disagreement exist. For example, we do not believe that in-stream productivity below the Green River site will recover as quickly as you project. This issue influences the success of mitigation measures. Clearly, permanent loss of potential habitat for anadromous fish will occur from project implementation, even with fish passage provided.

2 We disagree, as well, on the issue of operations and maintenance funding for fish passage facilities. Our experience is that the Corps of Engineers has been responsible for funding fish and wildlife mitigation programs at Corps-owned and operated dams in the state of Washington. Examples are Wynoochee Dam on Wynoochee River and Mud Mountain Dam on White River.

Finally, we reiterate our concurrence with your choice of the preferred alternative. The following recommendations are given to help design and implement an effective mitigation plan.

1. Greater consideration should be given to all measures proposed in the final U.S. Fish and Wildlife Service's Coordination Act report.

2. A technical committee of state and federal fish and wildlife resource agency personnel should be established to review plans and give advice on mitigation issues.

2 3. Studies for planning, feasibility and design of fish and wildlife mitigation resources should coincide with other project features, beginning with receipt of FY 85 planning and design funds.

4. Fish passage should be provided at all times during and after construction.

5. Monitoring of fish and wildlife response to construction and mitigation actions should begin at project initiation, and continue until mitigation needs are satisfied.

Thank you for giving us the opportunity to respond to your document.

Very truly yours,

THE DEPARTMENT OF GMAE

Frank R. Lockard
Director

FRL:pr-b

Responses to Dept. of Game Comments:

1. Comment noted.

2. Please refer to similar recommendation provided by U.S. Fish and Wildlife Service and our responses to those recommendations which are included with the Coordination Act Report in Exhibit 1 of the Main Report.

Willapa Hills Audubon Society

P. O. Box 93 - Longview, WA 98632

November 28, 1984

Colonel Robert L. Friedenwald, District Engineer
Portland District
U.S. Army Corps of Engineers NPPPL-AP
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald:

The Willapa Hills Audubon Society supports the selection of the Green River site for construction of a sediment retention dam to control flooding in the Toutle, Cowlitz and Columbia Rivers. This site poses the least adverse effects on fish and wildlife resources.

We recommend that fish and wildlife be made an authorized purpose of the dam project to ensure that appropriate mitigation measures for habitat losses are implemented. While losses would not be as severe with the Green River site, as with the other alternatives, impacts still would occur and they must be mitigated.

Continued fish and wildlife habitat protection throughout the life of the project would be needed. A monitoring program should be established to assess the effectiveness of protection and mitigation efforts.

Adequate funding should be included in project budget requests to properly mitigate fish and wildlife habitat losses as recommended by state and federal resource agencies. Mitigation activities may include fish passage and rearing facilities, riparian zone protection, and wildlife habitat enhancement. We believe funding for fish and wildlife habitat protection and mitigation of losses should come from the federal government. The beneficiaries of fish and wildlife habitat protection and mitigation of losses are not limited to the local community or even the State of Washington. Anadromous fish are a regional, national and international resource; migratory birds are a regional and national resource. Furthermore, local and state governments cannot afford to implement the recommended mitigation and protection measures or to maintain them over the life of the project. For example, the fish trap is estimated to cost $1 million to construct and $100,000 a year to maintain and operate. If left to local and state governments to fund, there is a very real danger that fish and wildlife mitigation would never be implemented. Therefore, the cost-share proposal is unacceptable.

Sincerely,

Mark Chilcote
President

Response to Willapa Hills Audubon Society Comments:

Please refer to similar recommendations by U.S. Fish and Wildlife Service and our responses to those recommendations which are included with the Coordination Act Report in Exhibit 1 of the Main Report.

Weyerhaeuser Company

Longview, Washington 98632
A/C 206 · 425-2150

December 14, 1984

COL. R. L. Friedenwald
Department of Army
Portland District, Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

Dear COL. Friedenwald:

The purpose of this letter is to offer Weyerhaeuser's comments on the draft Mt. St. Helens Feasibility Report. One year ago Weyerhaeuser joined with others in urging the Corps to begin construction of a permanent outlet for Spirit Lake. With that project nearing completion, we commend the Corps of Engineers for your prompt response. Like the Spirit Lake tunnel project, the transport of sediment through the Toutle, Cowlitz and Columbia River systems is a complex problem with very costly solutions.

Weyerhaeuser has a large stake in the sediment and flood control efforts in the Toutle and Cowlitz River valleys. Not only are we the largest land owner in the Toutle drainage, but our 670 acre Longview mill site includes improvements valued at close to $1 billion. Our pulp and paper facilities are currently involved in major capital investment projects. Our timberlands and manufacturing facilities support over 4,000 jobs with an annual payroll in excess of $155 million. With a high level of interest, we offer comment on three items: SEDIMENT BUDGET, ALTERNATIVE SELECTION, AND FUNDING.

SEDIMENT BUDGET

Selection of a management strategy is primarily driven by the source, amount and timing of sediment transport. Information on the dynamics of these critical elements remains incomplete. The Corps most recent Sedimentation Study reinforces this position by concluding that major downward revisions were needed in the sediment budget. We support the Corps determination that monitoring and refinement of sediment data should continue. Uncertainties in the following areas highlight the need for additional information:

- The absence of an intense storm event during the 3-year study.
- Record rainfall in water year 1984 not included in the study.
- Dynamics of scour/infill patterns.
- Re-entry of sediment from spoils disposal sites.
- Rapid re-establishment of stream channels.
- Rapid recovery of the South Toutle and Green River.
- Sediment contribution from current Spirit Lake pumping versus the tunnel outlet.
- Significant bank erosion on Toutle and Cowlitz rivers.

These uncertainties demonstrate the complexity of processes effecting sediment projections. We support strengthening sediment transport data prior to final selection of a management strategy.

ALTERNATIVE SELECTION

The Feasibility Report recommends that a 177-foot Single Retention Structure (SRS) be constructed to trap sediment. If it is finally determined, after additional monitoring, that the SRS is justified, Weyerhaeuser would support the Green River site for location of the structure.

As the major landowner within the proposed SRS project boundary, Weyerhaeuser will suffer major damage to forestland inside the project as well as added cost of managing lands surrounding the SRS. Included are:

- Timber of various ages.
- Land.
- Roads and bridges - both public and private.
- Log handling facilities.
- Railroad routes.
- Minerals.
- Power and utilities.
- Severance damages.

Specific measures described in the Feasibility Report to minimize impacts of the project on fish and game are sufficient. Weyerhaeuser is committed to long term forest management on its St. Helens Tree Farm. Inherent in this commitment is the maintenance of normal forest practices which are compatible with fish and game resources. Weyerhaeuser will resist any attempts to expand mitigation measures to involve additional land or forest management restrictions.

FUNDING

Development of any management strategy must include full identification of all costs to all parties. We support traditional funding methods as the fair and most rapid approach to get the job done. At issue is the threat to lives and property resulting from a natural disaster. The threat to

commercial navigation in the Columbia and Snake River systems affects several states in this region. In addition, the bulk of erodible sediment originates in the National Volcanic Monument on federal land. In view of these conditions, funding of a solution is an appropriate role for the Federal government. Congressional authorization and funding must include prompt compensation to all property owners affected. The Corps dredging program on the lower Toutle and Cowlitz River has effectively provided flood protection. Funding for this maintenance dredging must continue.

In summary, continued monitoring and refining of the sensitivity analysis is needed before an appropriate management strategy can be selected. We appreciate the opportunity to comment on your draft Feasibility Report and Environmental Impact Statement.

Sincerely,

C. H. Wiggins
Vice President
Southwest Washington Region

CHW:sj
07/121484

cc: Mr. Lloyd Stoats
Resident Engineer
Army Corps of Engineers
P.O. Box 190
Castle Rock, WA 98611

Responses to Weyerhauser Co. Comments:

We agree that continued monitoring and refinement of the sediment budget is needed. However, the high cost of continuing interim dredging, to prevent flooding and navigation blockage, requires that steps continue to implement a solution. We are continuing planning and engineering on single and staged retention structures along with dredging alternatives. This will minimize delays if new sediment information indicates another alternative is more cost effective.

A. H. Jones
12-10-84

Comments Concerning
Mt. St. Helens, Washington, Feasibility Study

The task of evaluating the river problems created by the eruption of Mt. St. Helens is not an easy one. These problems are not only, as described by the Army Corps of Engineers, "unlike any others experienced in the United States," but the erosion process has refused to settle into a consistent pattern thus becoming, in effect, a moving target for the Corps' evaluation marksmen.

Comprehensive Plan was published in November, 1983, and within a few months was recognized to be out of date. The target had moved.

Sedimentation Study/1984 was released in September, 1984, as an update of Comprehensive Plan with extensive revisions of the earlier evaluation. The revisions included:
1) forecast of 50-year erosion reduced from 1 bcy to 650 mcy.
2) forecast of 1985 erosion reduced from 50 mcy to 28 mcy.
3) capacity of proposed dam reduced from 712 mcy to 299 mcy.
4) cost of preferred project reduced from $342 million to $292 million.

Among the reasons why Comprehensive Plan missed the target are these:
1) forecasts of erosion were too high because they were based on early post-eruption winters when erosion was high.
2) erosion reports for recent winters, showing erosion decline, have been repeatedly delayed for one year.
3) unrealistic worst-case interpretations have characterized the evaluation system.

Those same defects have been repeated in the 1984 Sedimentation Study and in the recent Mt. St. Helens Feasibility Report. Data bases much too high, critical reports not available and unrelenting emphasis on worst-case conclusions may have flawed the credibility of the two documents.

The Corps' preferred plan is for a sediment dam in the Toutle River valley. This seems strange for the Corps has not yet verifiably defined the problem that the dam would theoretically solve. Two studies of the problem within the last year have produced answers far apart. The Corps has promised to continue its studies and, if erosion on the avalanche continues to change as drastically as before, the next report will produce still another set of answers.

It appears that the Corps guessed wrong in the beginning, assuming that erosion rates would remain high and might go higher. Erosion has done neither of these and has actually declined significantly, leaving the Corps constantly trying to catch up. Perhaps the Corps should recognize the reality of declining erosion and address the problem from a different direction.

There is no doubt that a person with realistic inclinations could take the same facts and figures used by the Corps and write a completely different report. Following are typical paragraphs from Feasibility Report, citing their defects and showing how they could be rewritten to correct mistakes, revise biased statements and replace worst case conclusions with optimism. The examples are numbered for reference.

1. Feasibility Report says on page I-1: "Further refinement of the plan presented in this report will occur during the Continued Planning and Engineering (CP&E)."

Overhaul of the plan was something more than a "refinement" and credibility of the report would be increased if spades were always called spades. The statement preferably would say: "The plan presented in this report is a major revision of the earlier plan and we anticipate further revision will be necessary when delayed data is available and new studies are complete."

2. Feasibility Report says on page I-4: "The revised sediment projections discussed in this report fall within the ranges of both total sediment erosion and annual rates of sediment delivery presented in those (Comprehensive Plan) sensitivity studies."

The Corps undoubtedly wishes this were true. However, it is not. The statement should say: "The revised sediment projections discussed in this report fall partly within and partly below the ranges of total sediment volume and annual sediment rates presented in Comprehensive Plan. This is due to our findings of sharply reduced current erosion. In Comprehensive Plan, a total sediment range of 400 mcy to 1 bcy was discussed; in Feasibility Report a range of 325 mcy to 975 is discussed. In Comprehensive Plan, an annual range of 30 mcy to 70 mcy was discussed; in Feasibility Report, various high ranges were discussed and an initial high rate of 28 mcy was chosen.

3. Feasibility Report says on page I-4: "The revised sediment projections discussed in this report fall within the ranges of both total --- and annual --- sediment delivery presented in (Comprehensive Plan)."

Comprehensive Plan and Feasibility Report not only discussed ranges of total and annual erosion but they also were very specific in making forecasts. The discussion of ranges was simply a method of arriving at the answers, and secondary in importance to the results. An informative wording might have said: "The revised sediment projections presented in this report were adopted following discussion of a wide range of total and annual erosion rate

possibilities, the lower range of which fell outside of the range of Comprehensive Plan discussions. As a result, the new forecasts are significantly below the earlier predictions: 650 mcy instead of 1 bcy for total erosion and 28 mcy instead of 50 mcy for year-1985 erosion."

4. Feasibility Report says on page I-4: "--- new information developed since completion of the Comprehensive Plan --- refine the projections on sediment movement and deposition."

The new information did more than refine the projections; it extensively revised them. A more realistic report of what happened would say: "Critical information which was late in coming to the Corps has caused the projections of sediment movement and deposition to be drastically revised."

5. Feasibility Report says on page I-10: "During the eruption, the avalanche --- (blocked) outlets to existing lakes."

Spirit Lake was the only Toutle basin lake whose outlet was blocked by the avalanche. This error may be small but any inaccuracy in a report such as this is a reflection on the objectivity of the document. The statement might say: "Following the eruption, the avalanche blocked the outlet to Spirit Lake, buried the upper North Toutle River and some of its tributaries, then moved down the valley blocking the outlets to other streams."

6. Feasibility Report says on page I-15: "A drastic reduction in the total sediment yield, from 1 bcy to 400 mcy would result in strategy 2 (SSB) being less expensive than strategy 5 (SRS)."

The statement reaffirms a Comprehensive Plan conclusion that for total sediment yields up to 400 mcy the sediment stabilization basins are the least costly alternative. The cost advantage for SSB is illustrated in Table I-2 on page 15 of Feasibility Report. The statement above would have been more informative if it had said: "The drastic reduction which has occurred in current sediment yields strongly indicates that total sediment yields have dropped below the 400 mcy level where cost advantages will shift from retension structures to dredging from stabilization basins. If this reduction is confirmed, we will find it advisable to change our preference from the high dam to the dredging program."

7. Feasibility Report, in Table I-3 on page I-15, compares the cost for disposing of three assumed annual sediment yields under five alternative management strategies.

The assumed yields do not include a column representative of the current rate of sediment movement. The table predictably shows SRS costs to be the most favorable. Actually the table is not relevent to the current sediment situation, since its range of annual sediment yields does not drop low enough to include the present rate of sedimentation as measured by the ongoing dredging operation. It would be realistic to revise the table to include a column for 10 mcy annual sediment delivery.

8. Feasibility Study says on page II-1: "The sediment budget used in the report is based on observed erosion and sediment movement --- during the past four years."

This statement is refuted on page II-7 where it is indicated that, if any observations were made after September 30, 1983, they were not used in establishing a sediment budget. The statement should say: "The sediment budget used in this report is based on our observations of erosion and sediment movement prior to September 30, 1983. During the preparation of this report, erosion and sediment data was not available for WY 1984 which included the fourth post-eruption winter. The omission of this critical information probably detracts from the validity of the sediment forecast and we realize the urgency to acquire the delayed data and to restructure the sediment budget."

9. Feasibility Report says on page II-1: "The uncertainties associated with the sediment budget developed for this report, as well as for the Comprehensive Plan, have been dealt with by performing sensitivity analyses on proposed management alternatives."

The statement implies that the difficulty of determining what the declining erosion process will do next has been successfully overcome. That is definitely not the case. The statement realistically should have said: "The uncertainties associated with sediment movement have made the development of a sediment budget very difficult. Sensitivity analyses have been performed on proposed alternatives but the basic data is so unrealiable, due to the constantly changing erosion process, that we are not comfortable with our sediment projection. We will, of course, continue our field observations and the annual updating of the sediment budget."

10. Feasibility Report says on page II-1: "These projections are unable to reflect possible large-scale erosion caused by unusual events. For example, the largest storm during the past 4 years had less than a 10-year occurrence frequency."

This does not tell the whole story. It would have been more informative to have said: "Although there has been no record-breaking storm event in the Toutle River watershed since the eruption, rainfall has been heavy. Rainfall records were kept at Spirit Lake from 1932 to 1956 and from October, 1983, to the present. For the months when rainfall was recorded at Spirit Lake, November, 1983, reported the second highest total with 29.62 inches for the month including 3.33 inches on one day. While these are not records, they are heavy, sustained rainfalls and it is significant that no unusual erosion or flooding occurred. Rainfall

records have been kept continuously at Longview since 1923 and these show that Spirit Lake rainfall is consistently about double the Longview measurement. Since Longview records indicate that annual rainfall has increased every year since 1979 and has been substantially above the average each year, we can assume that more than 100 inches of rain has fallen on the debris avalanche every year since the eruption. While not enough to cause a deluge, it may have been sufficient to test the stability of the debris."

11. Feasibility Report says on page II-6: "Sediment yields from the debris avalanche are expected to remain high throughout the 50-year project life."

Sediment forecasts for just one year have been far off the target and it is unlikely that expectations for the next 50 years will be any closer. It would have been sufficient to say: "Sediment yields from the debris avalanche were understandably high during the early post-eruption years but the yields have dropped sharply since the second winter following the eruption. Inasmuch as tributary streams are generally clear and the outlet tunnel from Spirit Lake will bypass six miles of the North Toutle River where it crosses the avalanche, we see good reasons to expect that yield from the avalanche will continue its decline and will remain substantially below the erosion rates of the past."

12. Feasibility Report says on page II-12: "The Comprehensive Plan --- assumed an initial rate of erosion equal to the then-estimated WYs 1981 and 1982 average of 50 mcy/year."

A better explanation would have said: "Comprehensive Plan estimated the erosion in WYs 1981 and 1982 to be 31 and 34 mcy respectively. The average of 32.5 mcy for the two years did not seem high enough for forecast purposes so we chose to call the average 50 mcy. We know now that we erred because the following year produced only 18 mcy of erosion from the avalanche. We are not yet ready to consider that figure indicative of current erosion rates, so we are forecasting 28 mcy for 1985. Our field reports of erosion are lagging one year behind but as soon as current data is available, we will formulate another forecast."

13. Feasibility Report says on page II-12: "The annual erosion rate has been reduced but continues at a uniform rate."

Erosion rates for WYs 1981, 1982 and 1983 were estimated on page II-7 to be 31, 34 and 18 mcy, respectively. It is doubtful that this can be regarded as an indication of uniformity. The absence of an estimate of erosion for WY 84 adds to the mystery of how anyone could judge the erosion rate to be continuing at a uniform rate. Evidence indicates that the statement could say no more than this and still be factual: "The annual erosion rate has declined and the last field report indicated a sharp drop in 1983. We cannot anticipate what the WY 1984 report will reveal but there seems a strong possibility that further decline will be noted."

14. Feasibility Report says on page II-21: "-- Comprehensive Plan showed a single retention structure (SRS) as the least costly solution to the sediment problem within the total sediment yield range of 400 mcy to 2 bcy."

Comprehensive Plan apparently does not say that. If the reference is to page VI-7 in the Plan, it will bear reading again. It says: "If the sediment yields are low (i.e. 400 mcy), the SSB (sediment stabilization basin) strategy has the lowest cost." Table VI-2, also on page VI-7, shows the SSB cost for a yield of 400 mcy is $218 million whereas the SRS cost for the same yield is $275 million. The statement should have said: "---Comprehensive Plan showed sediment stabilization basins to be the least costly solution for sediment up to and somewhat above 400 mcy. For higher volumes the single retention structure appeared to be the least costly."

15. Feasibility Report says on page II-21: "The revised sediment budget indicated the feasibility of a smaller structure ---. However, additional storage needed for --- flood events and mudflows dictated that a structure the same size as in the Comprehensive Plan still was needed."

Comprehensive Plan erosion estimates have been drastically revised. To say that the proposed dam, which was intended to handle the higher volume, still is required is irrational. The statement would be realistic if it said: "The revised sediment budget indicates the feasibility of a smaller structure, which, frankly, is the only dam which can be statistically justified at this time. Because of delayed erosion data, we aren't even sure how small the dam should be. However, if it is agreed that, in the interest of caution, provision should be made for trapping mudflows or storm events which may or may not occur, then it might be advantageous to choose a dam with greater storage. We believe that mudflows and storm events are a possibility and, in order to play safe, we recommend a structure the same size as in the Comprehensive Plan."

16. Feasibility Report says on page II-21: "The new total sediment yield from the debris avalanche approximates 750 mcy and the annual sediment yield 28 mcy/year, beginning in 1980."

This is a garbled sentence which perhaps intended to quantify two factors and actually confused both. Following may have been the intention: "The new total sediment yield from the debris avalanche is predicted to be 750 mcy during 55 years beginning in 1980 following the eruption and the declining annual sediment yield is forecast to be 28 mcy in 1985."

17. Feasibility Report says on pages II-21/22: "--- the total quantity of sand delivered over the project life remains virtually the same as in the Comprehensive Plan."

This is an incredible mathematical coincidence when we consider the drastically declining erosion from the avalanche and the low volume of sand that has been dredged from the combined Toutle, Cowlitz and Columbia Rivers. It might have been more acceptable to have said: "--- the total quantity of the sand portion of the eroded material expected to be delivered over the project life was calculated to be similar to the volume estimated in the Comprehensive Plan. This projection will probably be changed after we receive the delayed erosion data and review the overall dredging information."

18. Feasibility Report says on page III-5: "Structure design includes fish by-pass facilities for anadromous fish."

Most people reading this statement will get a clear picture of a fish ladder or lift of some kind. Nothing of this kind is being planned. What is being considered is a provision for trucking the fish from the river below the dam to the pool above the dam. The statement should have said: "The structure to be designed is not expected to include any facility for passing anadromous fish over the dam. If any provision is provided for fish passage around the dam, it will be separate from the structure itself and will possibly consist of a holding pool for the fish below the dam and a tank truck to transport the fish around the structure."

19. Feasibility Report on page IV-9 lists advantages of a single retention structure and adds: "It also would cause the least disruption of the physical environment and related resources."

This is not a true statement and it would be better to say: "Regrettably the dam would environmentally damage 6 miles of the North Toutle River, 5 migratory-fish creeks and 4,100 acres of river valley land, all of it downstream from the 16 miles of river damaged by the mudflow of May 18, 1980. This is far more disruption than would be caused by a smaller dam, a dam located farther upstream or by dredging from sediment stabilization basins."

20. Feasibility Report says on page IV-14: "Appendixes C and D present the details of the estimated sediment budget --- of 750 mcy for the next 50 years."

The volume of 750 mcy does not conform to Sedimentation Study/1984 most of which was incorporated into Feasibility Report as Appendix C. SS/1984 says at the bottom of page 2: "The total erosion from the debris avalanche during the next 50 years would be approximately 650 mcy." The use of 750 mcy instead of 650 makes the sedimentation situation appear more severe than it really is. It is unfortunate that this error was continued throughout Feasibility Report, and even into the calculations for Sediment Budget E.

21. Feasibility Report says on page IV-14: "The Corps' current estimate of future sediment is the E sediment budget (of 750 mcy), since it has the highest probability of occurring."

In view of the difficulty in predicting sediment probabilities, it might have been better to say: "The Corps' current estimate of future sediment is the E sediment budget of 650 mcy. However, erosion from the debris avalanche has declined so drastically during the last two years that we have no basis for confidence in our E budget. It is the best estimate that can be made at this time and we will not be surprised if it requires revision in a short time."

22. Feasibility Report says on page V-14: "In sum, the preferred plan would strengthen the underlying economic base of Cowlitz County and enhance its quality of life."

If this is a major and verifiable benefit of the dam project, it should be publicized extensively.

23. Feasibility Report says on page VI-11: "Results from this table (Table VI-4) indicate that for a 1/2 sediment budget, dredging is always the least costly solution."

The sediment budget has been set at 650 mcy for the 50-year life of the project. This probably will be reduced when current field data becomes available but, even so, one-half of the budget is 325 mcy and that is in the range of what we are talking about. The proposed dam would have a preferred trapping capacity of 299 mcy, which is less volume than the 1/2-budget figure. Would it not be factual to amplify the above statement by adding: "We have reason to believe that 1/2 sediment budget is a realistic figure to work with at this time. Accordingly, we have indicated our preference for a dam which will trap 299 mcy of sediment. We recognize that 299 mcy is below the 1/2-budget level where dredging from stabilization basins is less costly than building a retention dam. If 1985 studies confirm the decline of sedimentation, we obviously must give consideration to [illegible]."

24. Feasibility Report says on page VII-3: "--- fish and wildlife impacts associated with a single retention structure need weighting against the downstream benefits attributable to such a structure."

This is a harsh over-simplification of one of the negative aspects of the proposed project. Those who are concerned about the fish and wildlife resources whose loss will be attributable to the dam will be quick to point out that environmental losses will be very real while downstream benefits will be largely theoretical. The statement would have been more palatable if it had said: "--- fish and wildlife impacts associated with a sediment dam in the Toutle River valley can be foreseen and estimated with fair certainty. Comparing these predictable losses against the list of downstream benefits, which are generally hypothetical, can quickly become an emotional confrontation. We shall refrain from taking sides in this trade-off argument until we have a better evaluation of the probabilities involved."

25. *Feasibility Report says on page IX-1: "Material eroding from this avalanche --- is reducing flood protection levels in downstream urban areas ---."* Having asserted that flood protection is declining because of sedimentation in the rivers, F. Report goes on to say: "Dredging is accomplishing the interim (100-year) flood protection authorized by PL 98-63, enacted in 1983."

It is possible to read these passages as saying: "We need a dam, but we don't need a dam." A more realistic statement might have gone something like this: "Material eroding from the avalanche moves downstream, some of it passing through to the ocean and the remainder depositing in the river channels. The sediment deposits, if not removed, could eventually create a flooding possibility for downstream urban areas. An active dredging program, however, has had no difficulty in removing the infill and maintaining the 100-year flood protection authorized by PL 98-63."

26. Feasibility Report says on page IX-2: "An SRS at the Green River site would create an impoundment of 3,267 acres."

Size of the impoundment is grossly underestimated since the acreage is actually about 4,100 acres. The statement, in the interest of accuracy, should say: "An SRS at the Green River site would create an impoundment of about 4,100 acres. An additional 3,373 acres of land outside the impoundment area will be needed for mitigation purposes. This additional acreage is hillside, timber-growing land and, as it is not actually required for the proposed sediment-dam project, we presume that the owner, Cowlitz County's largest industrial employer, will resist giving it up."

Conclusion

The Corps of Engineers has a timetable for building a sediment dam in the Toutle River valley. Anyone who is thoroughly familiar with the Mt. St. Helens/Toutle River country cannot read the Feasibility Report without realizing that it strives to bolster the very weak justification for the dam. This paper points out some of the more conspicuous flaws in the arguments.

It is suggested that the Corps put its timetable on Hold until the erosion data base is up to date and the nature of the sedimentation problem is fully understood. A written acknowledgment and reply to this suggestion is requested.

Alden H. Jones

Alden H. Jones
130 Jones Road
Kelso, WA 98626
Phone - 206 423 6626

RESPONSE TO ALDEN JONES

1. The statement in the draft is accurate. The plan presented in the Feasibility Report is a refinement of the Comprehensive Plan. Work performed during continued planning and engineering (CP&E) will be a refinement of the Feasibility Report plan. As the system adjusts appropriate refinements will be made.

2. This report utilizes the formulation process developed in the Comprehensive Plan (see Appendix A). It also contains the sensitivity analysis presented in the plan (see Appendix B) which shows the single retention structure as the least costly solution to the sediment problem. The revised sediment projections discussed in this report fall partly within the partly below the ranges of total sediment volume and annual sediment rates presented in the Comprehensive Plan. <u>This is due to our findings of reduced observed erosion. In the Comprehensive Plan, a total sediment range of 400 mcy to 2 bcy was discussed; in the Feasibility Report a range of 325 mcy to 975 mcy is discussed. In the Comprehensive Plan, an annual range of 30 mcy to 70 mcy was discussed; in the Feasibility Report, various ranges were discussed and an initial annual rate of 28 mcy was chosen. A discussion of the impacts of the new sediment budget on the sensivity analysis contained in the Comprehensive Plan follows in Chapter II.</u>[1]

3. Comment is addressed in changed paragraph for page I-4 of Feasibility Report, as shown in 2. above.

4. In developing a permanent solution to the sediment problem, it became necessary to incorporate new information developed since completion of the Comprehensive Plan. These new data revised the projections on sediment movement and deposition. The major problems remain the increase in potential flooding to communities along the Cowlitz River, potential impacts due to interruption of the transportation corridor crossing the Toutle River, and potential disruption of navigation on the Columbia River.

[1]Underlined text reflects changes in main report.

5. Statement in report modified to reflect suggested changes.

6. The information available at this time does not support a drop in sediment yields to below 400 mcy. Sedimentation studies will continue during CP&E and new information will be evaluated as it becomes available. Every effort will be made to include WY 1985 data in the CP&E sediment forecast (see response to comment 7).

7. Table 1-3 shows only the results that were developed during the Comprehensive Study, and has been uncluded only to show part of the background used in the evaluation of the answers presented in the Feasibility Report.

8. The uncertainties associated with the sediment budget developed for this report, as well as that for the Comprehensive Plan, have been dealt with by performing sensitivity analyses on proposed management alternatives. Monitoring and refinement will continue during the design phase to incorporate the most up-to-date sediment information available. The sediment budget used in this report is based on observed erosion and sediment movement from the debris avalanche in the Toutle-Cowlitz system during the past 4 year. Data available included Cowlitz-Toutle suspended sediment data through September 30, 1983, Cowlitz-Toutle River cross sections through April 1984, U.S. Geological Survey debris avalanche cross sections through early 1984 and debris avalanche backhoe soil samples from May 1984. Projections for future erosion and sedimentation are based on these observations and the average hydrology of the past 50 years. The largest storm during the past 4 years had approximately a 10-year occurence frequency. While there has been no extremem post-eruption storm event, Spirit Lake has experienced several intense rain storms. Monthly rainfall in November 1983 was 229 percent of normal, including an intense 3.3 inches on one day. It is expected that large quantities of material will erode with extreme events (100-year and above) or as a result of volcanic or hydrologic events. Although no historical basis exists for raising the current sediment budget, sediment ranges on the high side have been considered in evaluating alternatives to cope with future special events.

9. Statement does not imply that problems associated with projecting future sediment yields have been overcome. It recognizes that there are uncertainties and we have dealt with these uncertainties by performing sensitivity analyses on proposed management alternatives.

10. Same response as comment 8.

11. Variations in rainfall and runoff account for most of the variation in sediment yields during the past 3 years. The water discharge versus sediment discharge relationships at the U.S. Geological Survey stream gages do not indicate a decline in suspended sediment rate during the WY 1981-83 period. This issue will be reviewed again during CP&E.

12. At the time the Comprehensive Plan was prepared our best estimates placed the average annual erosion at 50 mcy/year during WYs 1981 and 1982. Improvements in the methods use and cross section data available resulted in the reductions presented in the Feasibility Report. We are again improving our methods and increasing our database during the CP&E sedimentation study and will make appropriate adjustments if needed.

13. Appropriate modification made.

14. Statement will be revised to say "... single retention structure (SRS) is generally the least costly solution to the sediment problem within the total sediment yield range of 400 mcy to 2 bcy."

15. The statement in the Feasibility Report is correct. Provisions for flood events and mudflows must be considered during plan formulation.

16. Statement in report modified to reflect suggested changes.

17. Statement is correct based on existing data. The sediment forecasts will be re-evaluated during CP&E, but it is too early to speculate on the outcome.

18. Statement in report modified to reference extent of fish passage facilities in Section V.

19. Of the alternatives analyzed, the preferred plan would cause the least disruption of the physical environment and related resources. This statement is substantiated by resource agencies. Specific impacts are more fully discussed in the environmental impact statement.

20. The "750 mcy over the next 50 years" should read "650 mcy over the next 50 years.

21. See response to comment 17.

22. The positive impacts of the preferred plan on the regional economy has been acknowledged by the County, affected ports, and individuals. The statement in the Feasibility Report appears adequate.

23. The : 2E budget was used during the sensitivity analysis to show cost impacts that would occur if annual sediment yield was less than that selected for design purposes. This should not be constured as a lack of confidence in the selected sediment yield based on existing data.

24. The U.S. Fish and Wildife Service has evaluated impacts to the resource above and below the structure. They have not indicated that downstream benefits are any more theoretical than the upstream losses. They acknowledge both benefits and losses will occur and both are difficult to quantify.

25. Statement in report modified to reflect suggested changes for clarification.

26. A SRS at the Green River site wouldimpound 299 mcy of sediment covering 3,267 surface acres during the 50-year project life. Ultimately 411 mcy of sediment would be trapped over 4,100 surface acres. Total project lands at the SRS site would total 7,470 acres.

Longview Washington
Dec 12 1984

Dist. Engineer,
Dear Sir

Our County Commissioner; Chamber of Commerce & Service Clubs are asking the citizens to write to you in favor of your corps to build a high dam on upper Toutle River.

I am one citizen who opposes any kind of a dam on Toutle River.

A number of years ago, I as a voter along with the majority of the voters of the state of Washington passed a law stating no more dams over twenty five feet high was to be build on any stream that flowed into Columbia River below Bonneville Dam.

I hope you take that into consideration before you go against the voters of Washington State.

Yours truly
Albert J Wuest

Response to Albert Weiss' Comments:

Thank you for bringing this issue to our attention. We have conveyed your concern to State of Washington officials.

Section 2: Comments without Specific Responses.

A summarization of these comments and our responses to them are found in the introduction to this exhibit.

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

Western Direct Federal Division
610 East Fifth Street
Vancouver, Washington 98661-3893

NOV 15 1984

IN REPLY REFER TO
HDF-17.121

Jon D. Katin, Lt. Col.
Acting District Engineer
Portland District, Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208-2946

Your Reference: Planning Division (NPPPL-AP)

Dear Col. Katin:

Washington FH Route 15, Mt. St. Helens Highway
Draft - Volume 1 - Main Report
Mt. St. Helens, Washington - Feasibility Report

Since the May 18, 1980, eruption of Mt. St. Helens, the Western Direct Federal Division of the Federal Highway Administration has assisted the Forest Service with the repair and reconstruction of 187 miles of roadway in the disaster area costing in excess of $27,000,000. Your proposal does not affect these Forest Development Roads and we have no preference to any sediment control alternative being considered.

It should be noted that SR 504 is a designated Forest Highway Route from I-5 to Coldwater Lake and, therefore, is eligible for Forest Highway funding as well as emergency relief monies referred to in Chapter X. We are not aware of any plans to use these very limited Forest Highway funds on SR 504, and any such use must be coordinated through the Gifford Pinchot Forest Engineer.

We also encourage your continued coordination with the Washington State Department of Transportation for any developments affecting SR 504.

We appreciate the opportunity to review the draft. Please feel free to contact us if you have questions.

Sincerely yours,

Glen Bedell for
James N. Hall
Division Engineer

Cowlitz County

BOARD OF COUNTY COMMISSIONERS

WALTER CHURCH JR	DISTRICT NO. 1
BERYL ROBISON	DISTRICT NO. 2
VAN A. YOUNGQUIST	DISTRICT NO. 3

December 10, 1984

Colonel Robert Friedenwald, District Engineer
U. S. Army Corps of Engineers
Post Office Box 2946
Portland, Oregon 97208

Re: Comments on Mount St. Helens Feasibility Report

Dear Colonel Friedenwald:

The Board of Commissioners believes the Mount St. Helens Feasibilty Report and the Draft Environmental Impact Statement are a thorough analysis of the sediment retention solution alternatives and the associated impacts. Three of our major comments on the Report are contained in the attached community consensus position statement. We heartily endorse the following three consensus points and rationale:

1. Implement a permanent sediment retention solution as soon as possible.

2. Recommend the preferred plan, a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement to the Administration and Congress.

3. Avoid requiring local governments to participate in funding this project.

In addition to supporting the consensus position, we would like to submit the following comments.

Timing of Implementation

For the past 4-½ years, we have advocated implementation of a permanent sediment retention solution as quickly as possible. We are now entering the fifth winter since the eruption. With each storm, we wonder how much longer our good fortune of no flooding will continue. Pages II - 1 & 2 of the Report speak to one of our gravest concerns.

> "The largest storm during the past 4 years had less than a 10-year occurrence frequency. It is expected that large quantities of material will erode from extreme events or as a result of mudflows from volcanic or hydrologic events."

By relying on interim dredging, we are risking substantial damages from large storms or back-to-back storms. There simply may not be time or suitable conditions to dredge the Cowlitz River during the winter. We need preventive action rather than reactive measures, and we need it as soon as possible.

207 FOURTH AVE. NORTH • KELSO, WASHINGTON • 98626 • TELEPHONE (206) 577-3020 SCAN 562-3020

The dismal economic picture in Cowlitz County has been compounded by uncertainty in river conditions. Business expansions have been curtailed and new businesses are locating in adjacent counties. Unemployment rates remain double digit month after month. We desperately need to stabilize and expand our economic base if we stand any chance of recovering from the recession. A number of other decisions are contingent on selection and implementation of a permanent sediment solution. The Department of Transportation cannot finalize the alignment of SR 504 until a decision on the retention structure is reached. DOT is prepared to rebuild the highway to Elk Rock by the time 1986 Expo opens in Vancouver, B.C. as soon as the final alignment decision is made.

Construction of a 177-foot sediment retention structure at the Green River Site **as soon as possible** is a critical component for improving our economic climate, restoring services and alleviating fears and anxiety among our residents.

Fish and Wildlife Mitigation

We have had the opportunity to review several drafts of the fish and wildlife mitigation report. The Fish and Wildlife Service kindly sent us the final draft Fish and Wildlife Coordination Act Report on November 23, 1984.

The issue of fish and wildlife mitigation has been difficult for us to resolve as we recognize that pre-eruption fish and wildlife resources were of significant value socially and economically to the local area. Especially since we are attempting to diversify our economic base by promoting tourism, we would like to see these resources recover to the fullest extent possible.

However we are keenly aware of the comments made to us by Mr. Don Craybill and Mr. Don Cluff, both OMB officials, in a June 20, 1984 meeting. They made it very clear that the Administration would support authorization and appropriations for a permanent sediment control solution only if it was not a "fish and wildlife Christmas tree", only if expensive mitigation plans were not required.

Neither Exhibit 1 in the Feasibility Report nor the final draft of the Coordination Act Report give us any idea of the total cost. This is of particular concern since page VII-4 of the Feasibility Report recommends that all fish and wildlife costs beyond construction of a fish by-pass facility be made a non-federal obligation.

We do not want fish and wildlife mitigation so expensive or so open-ended that it prices the federal government out of this project. We cannot possibly afford to provide compensation for the eight Columbia River sites identified in the final draft Coordination Act Report. Hundreds of acres of land would need to be purchased to achieve zero net loss of habitat. It is totally beyond the resources of local governments to even consider such a proposal. We believe that OMB would consider this a "fish and wildlife Christmas tree" if such a request was made for federal funding.

We are also concerned about the impact on private lands of one of the final draft Coordination Act Toutle River recommendations. It requests temporary cessation of timber harvest along the Green River, North Fork Toutle River and upper Hoffstadt Creek. We believe that private landowners will maintain strong opposition to any timber harvest restrictions on their lands. The potential for this kind of controversy could easily delay the project.

It should be made clear that Cowlitz County is not trying to kill fish and wildlife mitigation. We support mitigation measures that are reasonable, accomplishable, affordable and will not delay the project. We are in total agreement with your general response on Page 1 of Exhibit 1. Mitigation should only be for those impacts caused by the sediment retention structure, and not from the eruption. The mitigation proposed in your Report is reasonable, and local governments in Cowlitz County cannot afford to pay for more.

Cost-Share - Land Acquisition

The County's position on cost-share is expressed in the community consensus position. Our inability to participate in funding the SRS project has been made more clear these past few weeks as we complete the 1985 County budget. Revenues are down. Deep cuts in many operational programs are necessary to keep the County solvent. We do not anticipate that our financial situation will improve in the immediate future. Therefore we simply cannot afford to cost-share this project.

Regardless of who pays for acquisition of lands, easements and rights-of-way for construction and maintenance of the project, the federal government should handle the acquisition process. We do not have the resources or expertise to accomplish a project. State condemnation laws would force project delays from nine months to one year. Only the Corps of Engineers has the capability of acquiring all the necessary lands without delay.

We realize that some of the above points are redundant of earlier County comments. They are no less important today. Indeed, as the final decision draws nearer we are more concerned than ever that the best interests of all our citizens are protected.

Thank you.

BOARD OF COUNTY COMMISSIONERS
OF COWLITZ COUNTY, WASHINGTON

Van A. Youngquist

Van A. Youngquist, Chairman

Walter Church Jr.

Walter Church, Jr., Commissioner

Beryl Robison

Beryl Robison, Commissioner

Enc.

Cowlitz County

BOARD OF COUNTY COMMISSIONERS
Walter Church Jr. DISTRICT NO 1
Beryl Robison DISTRICT NO 2
Van Youngquist DISTRICT NO 3

DEPARTMENT OF COMMUNITY DEVELOPMENT — PHYSICAL PLANNING • CODE ENFORCEMENT

SUMMARY OF LOCAL GOVERNMENT EXPENDITURES
AS A RESULT OF THE MOUNT ST. HELENS ERUPTION
DECEMBER 1984

Cowlitz County	$ 3,133,400
City of Longview	531,816
City of Kelso	234,589
City of Castle Rock	947,791
City of Woodland	905
Cowlitz-Wahkiakum Governmental Conference	18,813
Cowlitz-Wahkiakum Health District	64,154
Longview School District	75,481
Kelso School District	5,712
Woodland School District	9,672
Beacon Hill Sewer District	20,535
Longview Diking Improvement District	161,550
South Kelso Diking Improvement District	837,920
North Kelso Drainage Improvement District	108,560
Lexington Flood Control Zone District	558,470
Port of Longview	91,241
Port of Kalama	141,565
Cowlitz County P.U.D.	424,373
Kelso Housing Authority	455
TOTAL:	$ 7,367,002

Source: Individual contact with each agency.

COWLITZ-WAHKIAKUM GOVERNMENTAL CONFERENCE

COWLITZ COUNTY ADMINISTRATION ANNEX
207 - 4TH AVE. N.
KELSO, WASHINGTON 98626
PHONE (206) 577-3041
SCAN - 582-3041

COWLITZ COUNTY
CITY OF LONGVIEW
CITY OF KELSO
CITY OF CASTLE ROCK
CITY OF WOODLAND
CITY OF KALAMA
TOWN OF CATHLAMET
PORT OF LONGVIEW
PORT OF KALAMA
COWLITZ COUNTY P.U.D. NO. 1
LONGVIEW SCHOOL DISTRICT NO. 122
KELSO SCHOOL DISTRICT NO. 453
BEACON HILL SEWER DISTRICT
WAHKIAKUM COUNTY PORT DISTRICT NO. 2
WAHKIAKUM COUNTY

December 13, 1984

Colonel Robert Friedenwald
District Engineer
U.S. Army Corps of Engineers
Portland, OR 97208

RE: Cowlitz-Wahkiakum Governmental Conference Position on Actions for the Long-Term Recovery from Mount St. Helens

Dear Colonel Friedenwald:

The Cowlitz-Wahkiakum Governmental Conference, a voluntary organization of seventeen general and special purpose governments, held a special meeting on December 6 to discuss the Corps' Mount St. Helens Feasibility Report and Draft Environmental Impact Statement. As a result of that meeting, the Governmental Conference supports the following positions addressed in that report.

1. <u>Measures to eliminate the risk created by sediment movement should be implemented as soon as possible</u>.

The Corps' report accurately and comprehensively describes the social and economic impacts to this area resulting from the persistent uncertainty about risks of flooding and volcanic activity. Severe stress has caused some local residents to leave the area. Investment strategies have changed. Business relocation and expansion decisions have been delayed, preventing this region from participating in the economic growth enjoyed by the rest of the country.

We urge you to approve and implement permanent solutions to the sediment in-fill problems as soon as possible. Reduced flood hazards would relieve anxiety among our residents, improve the climate for business and investment, strengthen the area's economic base, and enhance our quality of life.

2. <u>The preferred plan, a 177-foot structure at the Green River site, downstream dredging and level reinforcement, is the best alternative solution</u>.

The preferred plan offers the greatest benefits for the lowest cost. The retention structure will store most of the material projected to erode from the debris avalanche to the Cowlitz and Columbia Rivers. It also has the capability of protecting the downstream communities, Castle Rock, Lexington, Longview and Kelso, by containing or reducing the design mudflow or the runoff from a 100-year storm. Because the plan combines dredging with a retention structure, it is the most adaptable to changing conditions in the Toutle River drainage basin. The plan would involve acquisition of the fewest number of individual parcels and occupied homes. It would also have the least impact on fish, wildlife and their habitats.

3. <u>Although the Feasibility Report recommends non-federal cost sharing for this project, we view mandatory participation by local governments in the funding arrangement unfavorably.</u>

The benefits from the preferred plan are not only regional, but also national in scope. The economies of Montana, Idaho, Oregon, and Washington are affected by the Columbia River navigation channel. Twenty percent of all foreign trade on the West Coast passes through the Lower Columbia River. The only railroad link between Portland and the Puget Sound Area crosses the Toutle River; in 1983, the Union Pacific and Burlington Northern Railroads carried 57 million tons of freight between those two markets. Interstate 5 connects the three West Coast states with Canada and Mexico. Over 11 million vehicles crossed the I-5 Toutle River bridge in 1983. It is of paramount importance to protect these facilities so that interstate and international commerce and transportation can be at least maintained, if not improved. All costs from projects, such as the preferred plan, which have such wide reaching impacts and benefits, are traditionally borne by the Federal government.

Finally, as mentioned earlier, the economic recovery experienced by the rest of the nation has not occurred here. Unemployment rates are consistently at least five percentage points higher than the national average. Because of the depressed local economy, it would be nearly impossible to generate the $17 million local share of this project. Moreover, if the project is not implemented, even more federal disaster relief funds will be needed in this area.

Thank you for the opportunity to comment on the Corps' report. We trust you to consider seriously these points as you develop your final recommendation to the Administration.

Very truly yours,

Floyd V. Carpenter

Floyd Carpenter
Chairman

FC:SU:hmb

719

CITY of CASTLE ROCK

P.O. Box 370 Telephone 274-8181
CASTLE ROCK, WASHINGTON 98611

November 27, 1984

District Engineer
U. S. Army Engineer District, Portland
Attn: NPPPL-AP
Post Office Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald:

At a regular meeting of the Castle Rock City Council held November 26, 1984, the City Council unanimously voted to express our support for the following positions on issues outlined in the Corp's Mount St. Helens Feasibility Report:

1. Implementation of permanent steps to eliminate danger created by sediment movement as soon as possible.

2. Construction of a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement.

Due to our current deficit caused by the Mount St. Helens disaster, we strongly urge 100% Federal funding of this project.

Please include this letter in the Public Hearing record.

Sincerely yours,

Michael D. Huson

Michael D. Huson
Mayor

MDH/pb

DENNIS P. WEBER MAYOR

THE CITY OF LONGVIEW

FOUNDED 1923

LONGVIEW WASHINGTON 98632

December 4, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Colonel Friedenwald:

RE: POSITION FOR LONG TERM
MT. ST. HELENS RECOVERY

The Longview City Council would like to express its support for the following position on issues addressed in the U.S. Corps of Engineers Feasibility Study of Mt. St. Helens.

1. *A permanent solution should be implemented as soon as possible to eliminate the risk created by sediment movement down the Toutle and Cowlitz Rivers.*

The City of Longview is experiencing major social and economic adversities resulting from the uncertainity about the risk of flooding and volcanic activity. The Corps of Engineers report is quite accurate in describing the impact to Longview and its residents. Community anxiety is heightened by the knowledge that a solution to the problem is neither simple nor likely to be implemented without delay.

A permanent long term solution once approved and implemented, would reduce flood hazards and restore normal social and economic conditions as well as improve the climate for investment and business. Long range planning and investment strategies by businesses who could relocate within the area are being unreasonably delayed. The unemployment rate within the City and Cowlitz County have continued in double digit percentage figures since September, 1980. The current unemployment rate is approximately 11%.

We support and urge you to approve and implement a permanent solution to the sediment problem and restore this community to its pre-Mt. St. Helens eruption position as soon as possible.

P.O. BOX 128, LONGVIEW, WASHINGTON 98632

2. *The City of Longview endorses and supports the preferred plan of the Corp of Engineers, to install a 177 foot structure at the Green River site, with downstream dredging and some levy reinforcement.*

Such a structure provides the greatest benefit at the lowest cost. It has the physical capability to store most of the material projected to erode from the debris avalanche, much of which will be deposited in the Cowlitz and Columbia Rivers over the fifty year projected life. Building the structure in one stage is the most cost effective solution. The structure as proposed has the capacity to contain and/or reduce peak flows from a design mud flow of 75 million cubic yards per year. This can be accomplished without worsening conditions at the structure site or damage to the cities downstream. The structure as proposed, will impact the fewest number of property owners and occupied homes within the area.

Of vital importance is the least negative impact that this proposal will have on fish and wildlife. Fish migratory paths to the south fork Toutle and Green River system will remain open. The bypass facilities proposed in this preferred plan will allow fish access above the structure in the north fork of the Toutle River. Reduction of sediment below the structure will provide some spawning and rearing habitat in the main stream of the Toutle River.

The Longview City Council would like to go on record in support of the quickest possible implementation of the preferred plan as proposed.

Sincerely,

CITY OF LONGVIEW

Dennis P. Weber
Mayor

DPW:JWB/ls

December 17, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Re: Community Consensus Position #2 for Long-Term
Mount St. Helens Recovery

Dear Colonel Friedenwald:

We, the undersigned representatives of local governments, service and civic organizations, express our support for the following positions on issues addressed in the Corps' Mount St. Helens Feasibility Report. Please include this letter in the public hearing record.

1. **We request that permanent measures to eliminate the risk created by sediment movement be implemented as soon as possible.**

   Our communities are experiencing the major social and economic effects that persistent uncertainty about risks of flooding and volcanic activity brings to an area. Your report is very accurate in describing the impacts to our communities and residents. Some individuals are showing symptoms of severe stress. Community concerns are intensified by the knowledge that solutions are neither simple nor likely to be implemented without some delay. Some residents have chosen to leave the area.

   Since long-range planning is impossible, investment strategies have changed and business relocation and expansion decisions are being delayed. Unemployment rates in Cowlitz County have been double digit every month since September 1980. The rate peaked at 20.5% in November 1982, but has been 15.2%, 14.5%, 13.3%, 13.7%, 12.6%, 12.2%, 12.5%, 12.1%, 11% and 12.1% the first ten months this year.

   Even though interim authorization, PL 98-63, requires that 100-year flood protection be maintained for urban areas along the Cowlitz River, your report indicates there is still the risk of $7.1 million residual average annual damages. The longer we must continue to rely on interim protection, the greater is the likelihood that these damages will be suffered.

   With a long-term permanent solution approved and implemented, reduced flood hazards would restore normal social and economic conditions and improve the climate for business and investment. Anxiety and uncertainty would be reduced among our residents. The underlying economic base would be strengthened and the quality of life enhanced. We urge you to approve and implement permanent solutions to the sediment infill problems as soon as possible.

2. **We support the preferred plan, a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement, for the following reasons:**

   a. It provides the greatest benefits for the lowest cost according to current data.

   b. It has the physical capability to store most of the material projected to erode off the debris avalanche and reach the Cowlitz and Columbia Rivers over the 50-year project life. Even if the projections on the amount of sediment erosion decrease in the future, we want a structure this size to handle extreme events. Available analyses indicate that construction in one stage is the most cost effective solution. However, we support continued sediment budget and sensitivity analyses to ensure final selection of the safest permanent design for implementation.

   c. It has the capacity to contain or reduce peak flows from a design mudflow (75 mcy) or a 100-year storm event. This can be done without worsening conditions at the structure site or at downstream damage centers (Castle Rock, Lexington, Longview and Kelso).

   d. It offers maximum flexibility to respond to changing conditions in the unstable Toutle River basin by combining a retention structure with some downstream dredging. It allows downstream dredging activity to increase at given locations if necessary depending on weather conditions. This is important since the current Cowlitz River levees can not be raised further without rebuilding the entire structure. Ground water levels in areas behind the levees have been rising as the river bottom infills. The ability to address these problems in the future must be retained in the preferred plan.

   e. It impacts the fewest number of property owners and occupied residences. Only 9 occupied residences out of 24 ownerships would be impacted compared to 13 occupied residences out of 73 ownerships at LT-3 and 34 occupied residences out of 94 ownerships at Kid Valley.

   f. It has the least impacts on fish and wildlife. Fish migratory paths to the South Fork Toutle and Green River system remain open. The by-pass facility proposed in the preferred plan allows fish access above the structure in the North Fork Toutle River. As sediment is trapped behind the structure, downstream riverbeds and channels will stabilize and turbidity will decrease. Reduction of sediment below the structure will provide some spawning and rearing habitat in the main stem Toutle River. As the channel stabilizes, quicker re-establishment of riparian vegetation will occur.

3. Non-Federal cost sharing is recommended in the Feasibility Report. We understand the basic concept of non-Federal cost sharing. However, for the following reasons we believe that local governments (e.g., counties, cities, and districts, etc.) should not be required to participate in funding this project:

a. The sediment structure is a permanent solution to a unique major disaster. Even with the structure, local governments will continue to respond to site specific, eruption-caused problems that do not qualify for federal funding. Since 1980, local governments in Cowlitz County have spent over $7 million on recovery measures that were not covered by federal programs. Examples of on-going expenditures include increased water system and diking district maintenance, additional road stability repairs, spoils site rehabilitation and other activities. This has and will continue to tax our financial viability. We simply cannot afford to cost share in the sediment structure while solving the many other related disaster recovery problems for which federal assistance is not available.

b. The sediment structure has regional if not national benefits. The Columbia River navigation channel is a major transportation facility that impacts the economy of Oregon, Idaho and Montana as well as Washington. In 1983, Oregon and lower Columbia River ports handled approximately 26% of all foreign trade conducted on the West Coast according to Corps of Engineers figures. More significantly this same region, which relies on the portion of the Columbia River impacted by Mount St. Helens, accounted for 37% of the export volume on the West Coast. The exports are primarily agricultural and commodity in nature bound for Pacific Rim markets. This is a significant contribution to solving the nation's balance of trade problems as well as assisting the agricultural community.

Interstate-5 and the Burlington Northern-Union Pacific -Amtrak rail line are vital land transportation links on the West Coast. In 1983, the I-5 average daily traffic count in both the north- and south-bound lanes at the Toutle River Bridge was 31,000 or 11,315,000 trips for the year. The Burlington Northern and Union Pacific Railroads moved approximately 57,000,000 tons of freight across the Toutle River railroad bridge in 1983. This means 27-36 trains per day including 6 Amtrak trains. This represents 100% of the train traffic between Puget Sound and Portland as this is the only north-south rail line between these two areas. The tracks must remain open to facilitate export grain movement from Puget Sound and Portland on down the West Coast. Costs to reroute that traffic across the Cascade Mountains to Spokane and down the Columbia River are astronomical.

Protecting all of these facilities is vital for interstate commerce and transportation. Traditionally the Federal government has paid all costs for projects having these kinds of regional and national benefits.

c. The source of the problem is located on Federal land. Within the North Fork Toutle River drainage basin, 44,400 acres are owned by the Federal government. That constitutes nearly all of the eruption impact area that is causing our problem. It is grossly unfair to ask local governments to pay any part of a problem that originates on Federal land.

Even though the rest of the country is apparently recovering from the recession, the recovery seems to have by-passed this State and especially Cowlitz County. Mount St. Helens recovery problems and economic problems have resulted in the high unemployment figures noted earlier. Many jobs have been lost in the forest products industries because of the loss in land base from the eruption devastation, reduced timber supply, export competition and shifts in market. Given the high unemployment rate, it is unfair to ask local governments to financially contribute to a sediment solution that originates on federal land and has national benefits.

d. The Federal government is eminently more capable of acquiring lands, easements and rights-of-way for this magnitude of project than local government. The Corps has a larger, more experienced real estate staff than any State or local agency. State condemnation laws would force project delays from nine months to one year. Since this project must be implemented as soon as possible, land acquisition must be handled as quickly as possible. Only the Federal government can accomplish the real estate transactions quickly enough to keep implementation on an acceptable schedule.

e. Administration officials have previously acknowledged the uniqueness of this disaster and the need for equity in financing a solution.

◇ July 16, 1981 testimony before Senate Subcommittee on Water Resources of the Committee on Environment and Public Works:

SENATOR GORTON: "Under your (100 percent federal cost recovery) proposals, in the event of a natural disaster of immense magnitude, obviously, I am referring to the eruption of Mount St. Helens, where literally millions of tons of material was put into the shipping channels overnight, the removal of which will require a number of years, would you expect the local entities to be responsible for recovering the cost of restoring a channel under your O & M proposals to its previous condition?..."

DAVID STOCKMAN: "I think you would want to make a distinction in the case of a rare and major catastrophe that isn't part of the normal cycle of siltation and development of other impediments to navigation. So I don't think that we would apply those unique and one-time costs to our concept of user recovery."

- June 9, 1982 letter from William Gianelli, Assistant Secretary of the Army for Civil Works, to the Cowlitz County Board of Commissioners:

"As a result of the meeting and follow-up actions, the President on May 18, 1982, directed the Secretary of Defense to have the Corps of Engineers prepare a comprehensive plan to deal with the long-term threat caused by the existing volcanic debris and sediment. .... The study will identify the most appropriate management measures in light of benefits and resources required to achieve these benefits, as well as the division of responsibility for implementation and funding of individual measures between Federal, State and local entities."

- January 16, 1984 letter from Assistant Secretary Gianelli to Governor Spellman:

"We are also in agreement that the Administration's proposed cost sharing (65% Federal - 35% non-Federal) policy for water projects in general is not appropriate for this problem. The tables presented in the document were intended only to illustrate parameters in the cost sharing negotiation process. Ultimately, depending on the solution chosen, there will need to be some sharing of costs among the various parties. Both the Federal government as well as the State and local governments will need to be involved in any arrangements which are finally worked out."

- January 24, 1984 letter from President Reagan to Senator Laxalt, Chairman of Appropriations Subcommittee on Commerce, Justice, State and Judiciary:

"All Federal water development agencies will continue to seek out new partnership arrangements with the States and other non-Federal interests in the financing and cost sharing of all proposed projects. Each such agency will negotiate reasonable financing arrangements for every project within its respective area of responsibility."

"Prior commitments to individual States with regard to water development within their borders must be considered and shall be a factor in negotiations leading up to project construction."

"Consistency in cost sharing for individual project purposes, with attendant equity, will be sought."

Thank you for the opportunity to comment on this report. We ask you to give the above points serious consideration when you reach the final recommendation that will be forwarded to Washington, D.C.

Cities, County, and Regional Government

Van A. Youngquist, Chairman
Cowlitz County
Board of Commissioners

John S. McKibbin, Chairman
Clark County Commissioners

Luther L. Peek, Chairman
Wahkiakum County Commissioners

John T. DeFrance, Director
Emergency Services for
Board of Commissioners,
Columbia County, Oregon

Dennis P. Weber, Mayor
City of Longview

Richard I. Woods, Mayor
City of Kelso

Michael D. Huson, Mayor
City of Castle Rock

R. L. Maruhn, Mayor
City of Kalama

W. K. Mills, Mayor
City of Woodland

Melvin Irving, Mayor
Town of Cathlamet

Floyd V. Carpenter, Chairman
Cowlitz-Wahkaikum Governmental
Conference

William V. Benson, Chairman
Skamania County
Board of Commissioners

Service Districts

Karen P. Pickett, President
Cowlitz Economic Development
Council

Robert L. McKinney
General Manager
Public Utility District No. 1
of Cowlitz County

Robert G. Guide, President
Longview School District
Board of Directors

Edwin P. Rutherford, President
Beacon Hill Sewer District
Board of Commissioners

Donald C. Maahs, President
Kelso School District
Board of Directors

Ernest S. Parrott, Chairman
Consolidated Diking
Improvement District No. 3
(South Kelso)

Jan D. Gano, Chairman
Castle Rock School District
Board of Directors

Wayne Daigle, Engineer
Consolidated Diking
Improvement District No. 2
(Woodland)

Mal Swanson, Superintendent
Kalama School District

Ports

Lloyd Anderson
Executive Director
Port of Portland

Larry M. Larson, President
Port of Longview
Board of Commissioners

John W. Pratt, Manager
Port of Kalama

Everett Groves, Chairman
Wahkiakum Port District No. 2

Peggy Bird, Executive Director
Pacific Northwest Waterways
Association

Charles R. Miller
Assistant to the Director
Port of Vancouver, U.S.A.

Unions

Vern Adams, Representative
Southern Washington Area
Association of Western
Pulp & Paper Workers

James R. Herron, President
International Longshoremen's
and Warehousemen's Union
Local #21

Richard D. Powell
Advisory Board Chairman
United Food and Commercial
Workers, Local #367

Harold B. McCorkle
Financial Secretary Business
Representative
Carpenters Union Local #1707

Laytbell J. Bales
Secretary-Treasurer
Teamster's Local #58

Political Organizations

David V. Creel, Chairman
Cowlitz County Republican
Central Committee

Gordon W. Sondker, Acting
Chairman, Cowlitz County
Republican Men's Club

Anna Niemi, President
Cowlitz County Republican
Women's Club

Dean A. Takko, Chairman
Cowlitz County Democratic
Central Committee

Todd Whitrock, President
Cowlitz County Democratic
Men's Club

Civic Organizations

Karl Salzsieder, President
Longview Chamber of Commerce

Chris Roubicek, President
Castle Rock Chamber of Commerce

Kathi Wheeler, Chairperson
Yale/Cougar Community Council

Gay V. Selby, President
Kelso Chamber of Commerce

Gloria L. Turner Rhodes
President
Kalama Chamber of Commerce

Other Organizations

Mark W. Chilcote, President
Willapa Hills Audubon Society

CITY OF VANCOUVER, WASHINGTON

City Hall, 210 East 13th St. - P O Box 1995
Vancouver, Washington 98668-1995

December 14, 1984

Colonel Robert Friedenwald
District Engineer
Corp of Engineers
P.O. Box 2946
Portland, OR 97208

Re: Community Concensus Position #2 for Long-Term
Mount St. Helens Recovery

Dear Colonel Friedenwald:

The City of Vancouver supports the position statements dated December 17, 1984, submitted to you by the Cowlitz County Board of Commissioners and others.

Sincerely,

BRYCE SEIDL
Mayor

PORT OF KALAMA

KALAMA, WASHINGTON, 98625, U. S. A.
P. O. BOX 7
(206) 673-2325

December 17, 1984

Colonel Robert Friedenwald, District Engineer
U.S. Army Corps of Engineers
PO Box 2946
Portland, OR 97208

RE: Comments on Mount St. Helens Feasibility Report

Dear Colonel Friedenwald:

The Port of Kalama Board of Commissioners strongly supports the implementation of a permanent sediment retention solution as soon as possible and the construction of a single, 177-foot structure at the Green River site, downstream dredging and some levee reinforcement as recommended in the Corps of Engineers' Mt. St. Helens Feasibility Report. The Commission also endorses the policy to avoid requiring local governments to participate in funding this project.

In addition to supporting the comments of the Cowlitz County Community Consensus Position, we wish to note an additional item of concern--the significant costs of mitigation as requested by the U.S. Fish and Wildlife Service. While we realize that the pre-eruption fish and wildlife resources were of significant value socially and economically to the local area, we do not feel that local governments should be asked to support mitigation efforts for this eruption circumstance. Mitigation should only be for those impacts caused by the sediment retention structure. We believe the Corps' preferred plan has the fewest short- and long-term impacts to fish and wildlife of any of the alternatives considered. As a matter of fact, the Corps' EIS states that the single retention structure will accelerate recovery of downstream channels and habitat, providing fishery benefits. We believe the SRS is a significant mitigation measure in and of itself. Any mitigation in addition to this would be an unreasonable burden to place on the local entities.

Thank you for the opportunity to respond to this project plan.

Sincerely,

John Fratt
Manager

JF/clm

Port of Kalama, Where Highway, Rail and Water Meet

Port Longview

December 10, 1984

Colonel Robert L. Friedenwald
District Engineer
Portland District, Corps of Engineers
Attention: NPPPL-AP
P. O. Box 2946
Portland OR 97208

Dear Colonel Friedenwald:

This position statement is presented on behalf of the Port of Longview Board of Commissioners in response to the Draft Mount St. Helens, Washington Feasibility Report & Environmental Impact Statement - Volume 1 - Main Report.

The Port's primary obligation and concern is to maintain navigation on the Columbia River and lower Cowlitz River. The port has signed a Resolution of Formal Assurances of Local Cooperation. To the extent that such undertaking is presently enforceable, the Port may be required to provide spoils disposal sites to maintain these channels. In the past has done so. The continuous and ongoing intrusion of sediment into these channels presents a major problem in furnishing sites. Also, due to severe depressed economic conditions in our local region (somewhat due to the eruption of Mount St. Helens and the ongoing volcanic action), the opportunity to develop spoiled lands economically places a premium on disposal sites. This matter is further compounded by mitigation for loss of wild life sanctuaries (wetlands) and loss of fish habitat.

If some method of sediment control is not put in place, the continuing maintenance of the navigation channels will become extremely expensive if not prohibitive.

This is aside from the fact that the lack of control places thousands of lives and millions of dollars of property in jeopardy.

The issue is not local nor even regional from the standpoint of economic impact. It is nationwide. The Columbia/Snake River watershed and its hinterlands are served not only by water transport but by interstate highway systems and primary rail carriers. Any interruption of the water transport system would result in all modes suffering severe economic loss and the ripple effect would be felt nationwide. Twenty percent of the West coast offshore trade is generated in the Columbia River port system. Of this 20 percent, 9 percent is import trade and 27 percent is export. This contributes significantly to a favorable balance of trade. This factor is also extremely important to the U. S. economy as one key industry is directly affected, AGRICULTURE.

PO Box 1258•Longview•WA•98632-0126 Tel 206•425•3305 Twx 910•473•8615

Port Longview

Colonel Robert L. Friedenwald
December 10, 1984
Page 2

The Port industry on the Columbia River has made sizeable investments in infrastructure to serve the offshore trade. The industry, as sponsors, has also made significant contributions in cooperation with the Federal government in developing and maintaining the waterway system.

Having cited the above circumstances, we adopt the following position:

1. Permanent sediment control by supporting the Preferred Plan for the 177-foot single retention structure at the Green River site with downstream actions, other miscellaneous actions and fish and wild life measures.

2. Reconsideration be given to the non-federal cost share as recommended by the feasibility report. The eruption of Mount St. Helens was a unique, one-of-a-kind disaster and its impact goes beyond local and regional boundaries.

We appreciate the opportunity to present our position. Please enter our letter in the record.

Respectfully submitted:
PORT LONGVIEW

BOARD OF COMMISSIONERS
Larry M. Larson
Ralph J. Holt
Lloyd V. Carpenter

POL/agm

PORT OF VANCOUVER USA

December 14, 1984

Col. Robert Friedenwald
District Engineer
Portland District U. S. Army Corp. of Engineers
P. O. Box 2946
Portland, Oregon 97208

Subject: Draft Feasibility Report and Environmental Impact Statement for Mt. St. Helens, Washington

Dear Col. Friedenwald,

Please refer to the Port of Vancouver U.S.A. response dated January 4, 1984 to "A comprehensive plan for responding to the long term threat created by the eruption of Mt. St. Helens, Washington".

We believe that the new draft feasibility report is a start to answer at least 2 of our 3 major concerns which were:

(1) Time/money - Now is the time -- no further studies are needed! Money cannot be the governing factor or we might be responsible for human lives, not just a 40' channel.

(2) Spirit Lake - A positive method of draining and reducing this level below the 3,440' elevation. The drainage must be maintained in the Toutle/Cowlitz Basin, the alternative to tunnel to Smith Creek into the Lewis River is not a good one. It would appear that conduits or open channel drains through any of the debris dams are not permanent solutions. Referring to the Figure VII-2 on Page VII-11 of the comp. plan we would recommend tunnels (F) or (G) - while more expensive, they might stand up better to eruptive or earthquake activity and above normal snow melt/rain/avalanche hazards normal in this area.

(3) Sediment Containment - This is a more complex problem but again another study and solutions because of cost are not the answer; in the best interest of life and navigation, a permanent containment plan and structure must begin as soon as possible. This control system should keep all sediment in the upper Toutle River Basin and minimize impacts on people, wildlife, resources and transportation. It would appear that in the interest of time and in the long term money that the single retention structure (Comp. Plan Page V-15, 16 & 17) would be the best.

The plan for drainage of Spirit Lake (2) and sediment containment (3) look good but when are they going to be done and who is going to pay. In other words, our No. (1) concern has not been answered.

We, the U.S. Government, Army Corp, Columbia/Snake River System, State of Washington, Cowlitz County, and the citizens directly involved, have been very fortunate. The U. S. Army Corp has done an excellent job in taking care of the immediate situation in May of 1980 and in all of the clean-up help, draining, planning from then until now -- thank you. We have also been fortunate in that we have not had assistance from mother nature in making another federal disaster. An earthquake of strong magnitude, heavy wet snowfall of unusual magnitude followed by a warm chinook with heavy rains, coupled with another eruptive phase could not only disturb navigation, it could change the direction of the Columbia River and take thousands of lives (human and animal) and billions of property and material with it.

The Port of Vancouver, Washington U.S.A. has endorsed the Cowlitz Community Consensus Postion #2 for long term Mt. St. Helens recovery and whole heartedly supports the oral and written testimony of the Pacific Northwest Waterways Association presented by Peggy Bird, Executive Director - November 29, 1984.

The U.S. Government cannot allow a 16.9 million cost sharing and local land securement project to hold up a program that insures human life and continuance of a major world transportation system that must be done now!!

We ask that you move on our behalf to please assist the U. S. Army Corps and Administration to move forward on this program immediately and thank you for your assistance in the past and future cooperation.

Yours very truly,

PORT OF VANCOUVER U.S.A.

Charles R. Miller

Charles R. Miller
Assistant to Executive Director

CRM:klf

729

Port of Walla Walla

Port of Walla Walla 29 E. Sumach, P.O. Box 1077, Walla Walla, WA 99362
509/525-3100

November 26, 1984

Colonel Bob Friedenwald, District Engineer
Portland District
U.S. Army Corps of Engineers
P.O. Box 2870
Portland, OR 97208

RE: Mt. St. Helens Feasibility Report

Dear Colonel Friedenwald:

Peggy Bird, Executive Director of the Pacific Northwest Waterways Association will present testimony regarding the referenced Report.

The Commissioners of the Port of Walla Walla concur and support the position of the Pacific Northwest Waterways Association. The Port of Walla Walla believes that damages caused by natural disasters should be corrected on a national basis, not on a state or regional basis.

We appreciate the opportunity to present our comments.

Sincerely,

Roy Nishi

Roy Nishi
Manager

Commissioners:
Ken Jantz
Wes Colley
Fred Bennett

Manager:
Roy Nishi

Member of
COLUMBIA SNAKE RIVER SYSTEM
REPRESENTING OVER 30 INDEPENDENT PORT DISTRICTS

Longview Public Schools
"In Pursuit of Excellence"

December 11, 1984

Colonel Robert Friedenwald
District Engineer
U.S. Army Engineer
Portland District
Attention: NPPPL-AP
P.O. Box 2946
Portland, OR 97208

Subject: Mount St. Helens Debris Containment Plan

Dear Colonel Friedenwald:

The Longview School District Board of Directors wishes to express its support of the position adopted by the Cowlitz County Board of Commissioners on the above subject, copy attached. With regard to the funding issue, our Board believes that any local taxes for this purpose would create difficult hardships on the local populace. Cowlitz County has never recovered from the recent recession, and any additional taxes would represent a serious hardship.

The Longview School District depends upon the generosity of its patrons to pass special levies with which to fund special programs or building projects. The Board of Directors fears that any new local taxes such as those suggested for the debris retention dam would jeopardize passage of levy and bond issues essential to public school operation. We, therefore, urge you to recommend funding for this project to be entirely from federal and state sources.

Needless to say, we unequivocably support the position that a permanent solution to debris containment be implemented promptly, and that the solution be a single retention dam on the Toutle River. Continued massive dredging is not a viable solution.

Yours truly,

Robert G. Guide

Robert G. Guide
President
Board of Directors

rkm/1759a

Enclosure:

ADMINISTRATION OFFICE
28TH & LILAC LONGVIEW, WA [illegible] [illegible]
SCAN [illegible]

CONSOLIDATED DIKING IMPROVEMENT
DISTRICT NO. 1
LONGVIEW, WASHINGTON 98632

SUPERVISORS
L. C. MILLER
CHAIRMAN
NOAH H. ANDERSON
SECRETARY
LYNN CLAPP
ENGINEER

District Engineer
County Administration Building
207 N. 4th
Kelso, WA 98626
Tel. 577-3029

Clerk-Attorney
P.O. Box 250
Longview, WA 98632
Tel. 423-4050

December 14, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

RE: Consolidated Diking Improvement District No. 1 of Cowlitz County - Position on Long-Term Mount St. Helens Recovery

Dear Colonel Friedenwald:

CDID No. 1 is the largest diking and drainage district located within Cowlitz County and is located at the confluence of the Cowlitz and Columbia Rivers. This district, due to its unique location, takes the following positions on issues addressed in the Corps Mount St. Helens Feasibility Report. Please include this letter and comments in the public hearing record.

1. Implement permanent measures to eliminate the risk created by sediment movement as soon as possible.

The communities involved are experiencing major social and economic effects arising from the uncertainty about risks of flooding the volcanic activity has brought to this area. The Corps' report is very accurate in describing the impacts to these communities and residents. Some individuals are showing symptoms of severe stress. Community concerns are intensified by the knowledge that solutions are neither simple nor likely to be implemented without some delay. Some residents have chosen to leave the area.

Long-range planning has been impeded. Investment from outside sources has been curtailed and business relocation and expansion decisions are being delayed. Unemployment rates in Cowlitz County have been double digit every month since September 1980. The rate peaked at 20.5% in November 1984, but has been 15.2%, 14.5%, 13.3%, 13.7%, 12.6%, 12.2%, 12.5%, 12.1%, and 11% the first nine months of this year. Even with the interim dredging allowed in PL 98-63, your report estimates $7.1 million in residual average annual damages.

A long-term permanent solution approved and implemented reducing flood hazards would restore normal social and economic conditions and improve the climate for business and investment. Anxiety and uncertainty would be reduced among district residents. The underlying economic base would be strengthened and the quality of life enhanced. We urge you to approve and implement permanent solutions to the sediment in-fill problems as soon as possible.

2. We support the preferred plan, a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement, for the following reasons:

a. It provides the greatest benefits for the lowest cost.

b. It has the physical capability to store most of the material projected to erode off the debris avalanche and reach the Cowlitz and Columbia Rivers over the 50-year project life. Even if the projections on the amount of sediment erosion decreases in the future, we want a structure this size to handle extreme events. Building it in one stage is the most cost-efficient solution.

c. It has the capacity to contain or reduce peak flows from a design mudflow (75 mcy) or a 100-year storm event. This can be done without worsening conditions at the structure site or at downstream damage centers (Castle Rock, Lexington, Longview, and Kelso).

d. It offers maximum flexibility to respond to changing conditions in the unstable Toutle River basin by combining a retention structure with some downstream dredging.

e. It impacts the fewest number of property owners and occupied residences. Only 9 occupied residences out of 24 ownerships would be impacted compared to 13 occupied residences out of 73 ownerships at LT-3 and 34 occupied residences out of 94 ownerships at Kid Valley.

f. It has the least impact on fish and wildlife. Fish migratory paths to the South Fork Toutle and Green River system remain open. The by-pass facility proposed in the preferred plan allows fish access above the structure in the North Fork Toutle River. As sediment is trapped behind the structure, downstream riverbeds and channels will stabilize and turbidity will decrease. Reduction of sediment below the structure will provide some spawning and rearing habitat in the main stem Toutle River. As the channel stabilizes, quicker re-establishment of riparian vegetation will occur.

3. Non-federal cost sharing is recommended in the Feasibility Report. The district understands the basic concept of non-federal cost sharing; however, for the following reasons, we believe that the district should not be required to participate in funding this project.

a. The sediment structure is a permanent solution to a unique major disaster. Traditionally the federal government has paid all costs associated with disaster recovery. The district will almost certainly need more disaster relief funds if this structure is not built, especially if abnormal conditions occur.

b. The sediment structure has regional if not national benefits. The Columbia River navigation channel is a major transportation facility that impacts the economy of Oregon, Idaho, and Montana, as well as Washington. Twenty percent of all foreign trade conducted on the West Coast passes through the portion of the Columbia River impacted by Mount St. Helens. Broken down further, it is 9% of the import volume and 27% of the export volume on the West Coast. This is a significant contribution to solving the nation's balance of payment problems as well as assisting the agricultural community.

Interstate 5 and the Burlington Northern-Union Pacific-Amtrack rail line are vital land transportation links on the West Coast. In 1983 the I-5 average daily traffic count in both the north- and south-bound lanes at the Toutle River bridge was 31,000 or 11,315,000 trips for the year. The Burlington Northern and Union Pacific Railroads moved approximately 57,000,000 tons of freight across the Toutle River railroad bridge in 1983. This means 27-36 trains per day including 6 Amtrak trains. This represents 100% of the train traffic between Puget Sound and Portland as this is the only north-south rail line between these two areas. The tracks must remain open to facilitate export grain movement from Puget Sound and Portland on down the West Coast. Costs to re-route that traffic over to Spokane and down the Columbia River are astronomical. Protecting all of these facilities is vital for interstate commerce and transportation. Traditionally the federal government has paid all costs for projects having these kinds of regional and national benefits.

c. The source of the problem is located on federal land. Within the North Fork Toutle drainage basin, 44,400 acres are owned by the federal government. That constitutes nearly all of the eruption impact area that is causing our problem. It is grossly unfair to ask the State of Washington and Cowlitz County to pay any part of a problem that originates on federal land.

Even though the rest of the country is apparently recovering from the recession, the recovery seems to have by-passed this state and especially Cowlitz County. Many jobs have been lost in the forest products industries because of a depressed national home building market, reduced timber supply and land base, export competition, and shifts in markets. Given the high unemployment rate, it is not only unfair, but highly unlikely, that the state and local government can generate $17 million for a project that has national benefits.

Thank you for the opportunity to comment on this report. The district asks you to give the above points serious consideration when you reach the final recommendation that will be forwarded to Washington, D.C.

CONSOLIDATED DIKING IMPROVEMENT
DISTRICT NO. 1

By
Noah Anderson, Supervisor

SLW:dw

COWLITZ ECONOMIC DEVELOPMENT COUNCIL

December 14, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Colonel Friedenwald:

The Cowlitz Economic Development Council urges the swiftest possible action to commence construction of a volcanic sediment retention dam on the north fork of the Toutle River. We also strongly support the dredging and dike protection work which is part of the overall volcanic sediment control plan proposed by the Corps.

For more than five consecutive years, this community has suffered from double-digit unemployment. The explosion of Mount St. Helens in 1980 with its concomitant threat to our communities and the Columbia River shipping channel exacerbated our economic problems.

It is absolutely essential that the Corps take all steps possible to eliminate the threat of volcanic sediment choking either the Cowlitz or Columbia river streambeds. The economic consequences, both locally and regionally, would be disastrous.

The most cost effective way of assuring a maximum level of protection for our communities and the Columbia River shipping channel is to build the retention dam.

We have every confidence that we can help restore our communities to economic prosperity but we must have the threat of flooding from sediment-choked streambeds behind us for good.

Mt. St Helens' sediment is more than an economic issue to us. The safety and welfare of the nearly 50,000 citizens who live downstream from Mount St. Helens is also at stake. Thus it is a public safety as well as an economic matter. Its urgency should be obvious.

Be assured we stand ready to assist in whatever way we can to speed this vital action along.

Sincerely,

Karen Pickett

Karen Pickett, President
Cowlitz Economic Development Council

kp/kc

cc: Senator Slade Gorton
Senator Dan Evans
Senator Mark Hatfield
Senator Bob Packwood
Representative Don Bonker
Representative Les AuCoin
Representative Norman Dicks

p.o. box 202 longview, washington 98632 (206) 423-9921

Longview Chamber of Commerce
1563 Olympia Way
Longview, WA 98632
Phone: (206) 423-8400

December 11, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Colonel Friendenwald:

The Longview Chamber of Commerce has carefully reviewed the Corps of Engineers Mount St. Helens Feasibility Report and has generally approved the following positions to be included in the public hearing record.

1. Implement permanent measures to eliminate the risk created by sediment movement as soon as possible.

   We are experiencing major social and economic effects that persistent uncertainty about risks of flooding and volcanic activity has brought to this area. Your report is very accurate in describing the impacts to our communities and residents. Some individuals are showing symptons of severe stress. Community concerns are intensified by the knowledge that solutions are neither simple nor likely to be implemented without some delay. Some residents have chosen to leave the area.

   Since long-range planning is impossible, investment strategies have changed and business relocation and expansion decisions are being delayed. Unemployment rates in Cowlitz County have been double digits every month since September 1980. Even with the interim dredging allowed in PL 98-63, your report estimates $7.1 million in residual average annual damages.

   With a long-term permanent solution approved and implemented, reduced flood hazards would restore normal social and economic conditions and improve the climate for business and investment. Anxiety and uncertainty would be reduced among our residents. The underlying economic base would be strengthened and the quality of life enhanced. We urge you to approve and implement permanent solutions to the sediment in-fill problems as soon as possible.

2. We support the preferred plan, a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement, for the following reasons:

   * It provided the greatest benefits for the lowest cost.
   * It has the physical capability to store most of the material projected to erode off the debris avalanche and reach the Cowlitz and Columbia rivers over the 50-year project life. Even if the projections on the amount of sediment erosion decreases in the future, we want a structure this size to handle extreme events. Building it in one stage is the most cost-efficient solution.
   * It has the capacity to contain or reduce peak flows from a design mudflow (75 mcy) or a 100-year storm event. This can be done without worsening conditions at the structure site or downstream damage centers.
   * It offers maximum flexibility to respond to changing conditions in the unstable Toutle River basin by combining a retention structure with some downstream dredging.
   * It impacts the fewest number of property owners and occupied residences.
   * It has the least impacts on fish and wildlife. Fish migratory paths to the South Fork Toutle and Green River system remain open. The by-pass facility proposed in the preferred plan allows fish access above the structure in the North Fork Toutle River. As sediment is trapped behind the structure, downstream riverbeds and channels will stabilize and turbidity will decrease. Reduction of sediment below the structure will provide some spawning and rearing habitat in the main stem Toutle River. As the channel stabilizes, quicker re-establishment of riparian vegetation will occur.

734

3. Non-Federal cost sharing is recommended in the Feasibility Report. We understand the basic concept of non-Federal cost sharing. However, for the following reasons we believe that local county, district and city governments should not be required to participate in funding this project.

   A. The sediment structure is a permanent solution to a unique major disaster. Traditionally the Federal government has paid all costs associated with disaster recovery. Even with the structure, the County will continue to respond to site specific erosion and flood control problems related to the Mount St. Helens disaster as mentioned above. This has and will continue to tax our financial viability. We simply cannot afford to cost share in the sediment structure while solving the many other related disaster recovery problems for which federal assistance is not available.

   B. The sediment structure has regional if not national benefits. The Columbia River navigation channel is a major transportation facility that impacts the economy of Oregon, Idaho and Montana as well as Washington. Twenty percent of all foreign trade conducted on the West Coast passes through the portion of the Columbia River impacted by Mount St. Helens. Broken down further, it is 9% of the import volume and 27% of the export volume on the West Coast. This is a significant contribution to solving the nation's balance of trade problems as well as assisting the agricultural community.

   C. Interstate-5 and the Burlington Northern-Union Pacific -Amtrak rail line are vital land transportation links on the West Coast. In 1983, the I-5 average daily traffic count in both the north and south-bound lanes at the Toutle River Bridge was 31,000 or 11,315,000 trips for the year. The Burlington Northern and Union Pacific Railroads moved approximately 57,000,000 tons of freight across the Toutle River railroad bridge in 1983. This means 27-36 trains per day including 6 Amtrak trains. This represents 100% of the train traffic between Puget Sound and Portland as this is the only north-south rail line between these two areas. The tracks must remain open to facilitate export grain movement from Puget Sound and Portland on down the West Coast. Costs to re-route that traffic across the Cascade Mountains to Spokane and down the Columbia River are astronomical. Protecting all of these facilities is vital for interstate commerce and transportation. Traditionally the Federal government has paid all costs for projects having these kinds of regional benefits.

   D. The source of the problem is located on Federal land. Within the North Fork Toutle River drainage basin, 44,400 acres are owned by the Federal government. That constitutes nearly all of the eruption impact area that is causing our problem. It is grossly unfair to ask local governments to pay any part of a problem that originates on Federal land.

   Even though the rest of the country is apparently recovering from the recession, the recovery seems to have by-passed this State and especially Cowlitz County. Mount St. Helens recovery problems and economic problems have resulted in the high unemployment figures noted earlier. Many jobs have been lost in the forest products industries because of the loss in land base from the eruption devastation, reduced timber supply, export competition and shifts in market. Given the high unemployment rate, it is unfair to ask local governments to financially contribute to a sediment solution that originates on federal land and has national benefits.

   E. Administration officials have previously acknowledged the uniqueness of this disaster and the need for equity in financing a solution.

Thank you for your consideration of this recommendation.

Sincerely,

Karl Salzsieder

Karl Salzsieder, President
Longview Chamber of Commerce

KS/cs

cc: Bob Arkell
Bob Korten
Lewis Bacon

Don Manasco, Manager

Phone (206) 636-3860

Beacon Hill Sewer District

1121 West Side Highway

Kelso, Washington 98626

December 6, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Re: District Position on the Mt. St. Helens Feasibility Report and Environmental Impact Statement

Dear Colonel:

We wish to express our support for the 177 foot Single Retention Structure at the Green River Site as the preferred alternative long-term solution to the sediment in fill problem resulting from the eruption of Mt. St. Helens. We feel this structure along with downstream dredging and protection of spoils already removed will best address the problem as now predicted and documented in your plan.

We do however, suggest that further consideration be given to your cost share proposal that places the cost of land and easement acquisition on the State and local government. This is a regional problem with national impacts. Regardless of the eventual cost responsibilities, the Corps should be authorized to acquire lands and rights-of-way. They are far better prepared and able to make these acquisitions on the most timely schedule than is the State or County. With a long planning and study process almost behind us, this would insure the most expedient and effective track for construction of the dam which is above all the main goal at hand.

Thank you for the opportunity to comment on this report.

Sincerely,

Edwin F. Rutherford, President
Board of Commissioners

EFR:jz

QUOIDBACH *Construction Co.*

QU-OI-DC*340LF

1355 CALIFORNIA WAY LONGVIEW, WASHINGTON 98632 PHONE 206 423-5810

December 13,1984

District Engineer
U. S. Army Engineer District, Portland
P.O. Box 2946
Portland, Or. 97208

Att'n: NPPL-AP
Re: Draft Feasibility Report and DEIS for Mt. St. Helens, Washington

Gentlemen:

Our firm came to Longview to build the town in 1923. As pioneer property owners, we have lived and worked behind the dikes of this city, comfortable with the job Consolidated Diking & Improvement District #1 was doing with our tax dollar to protect our interests. However, Mt. St. Helens explosive elevation of the gradient of the headwaters of the Toutle River with highly erosive material has presented our area with an immediate problem we are incapable of dealing with alone. Uncle Sam's Volcanic National Monument will continue to invade our territory with each successive storm.

As a graduate engineer, I have studied in depth both your comprehensive plan and this report and offer my congratulations on a job well done. I basically support the conclusions reached and favor the 177 foot Toutle sediment retention structure above the confluence of the Green River.

Regarding page VII-4, Division of Responsibilities, I have several concerns. Although I recognize the principal of cost sharing, I question the Non-Federal share inclusion of the costs of all lands, etc. and the ambiguity of the wording of "all other mitigation costs of the project".

In its geological lifetime, this area will become a terrace with a concrete waterfall. It would make a unique Federal Park or future entrance to the National Monument, or the land could be interumly leased from Weyerhaeuser, the principal owner, to be returned to their tree farming program.

I am afraid that mitigation costs may be construed by the fishery interests to include compensation and programs to restore the depleted Columbia Basin fish runs. This is a Federal and Regional problem.

Regardless of how Congress elects to fund this work, I hope that it will be expedited without further delay.

Yours truly,
QUOIDBACH CONSTRUCTION COMPANY

R. E. Quoidbach

By: R. E. Quoidbach

REQ/ml

LONGVIEW FIBRE COMPANY

MAIN OFFICE AND MILLS LONGVIEW WASHINGTON 98632
1 206 425 1550

December 3, 1984

R. L. Friedenwald
Colonel, Corps of Engineers
District Engineer
U.S. Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald:

Enclosed are Longview Fibre Company's written comments concerning the Corps' Mount St. Helens Feasibility Report, in follow-up of my statement in behalf of the Company at the November 29, Public Meeting at the Columbia Theater, Longview. We appreciate the opportunity to comment on this important issue.

Sincerely,

Curt Copenhagen

Curt R. Copenhagen
Director of Public Affairs

jb

cc: Van Youngquist, Chairman
Board of Cowlitz County Commissioners

R. B. Arkell
Vice President-Industrial Relations

TESTIMONY ON "MOUNT ST. HELENS FEASIBILITY REPORT,"
U.S. ARMY CORPS OF ENGINEERS, PUBLIC MEETING,
NOVEMBER 29, 1984, COLUMBIA THEATER, LONGVIEW
BY CURT COPENHAGEN, DIRECTOR OF PUBLIC AFFAIRS,
LONGVIEW FIBRE COMPANY

Colonel Friedenwald, Ladies and Gentlemen:

I am Curt Copenhagen, Director of Public Affairs for Longview Fibre Company, Longview, Washington. Thank you for the opportunity for our Company to comment on the Feasibility Report and the Corps' preferred plan for permanent Rivers Sedimentation Control which means so much to the entire region and to Longview Fibre.

We support the Corps' preferred plan of a 177' single retention structure on the North Fork Toutle River at the Green River site, dredging downstream, and some levee reinforcement. A permanent solution to the rivers' sedimentation problems is essential, because the sediment is a continuing threat to our large papermaking operations located near the confluence of the Cowlitz and Columbia Rivers.

Substantial quantities of our raw material, wood chips, and also a source of energy, hogged fuel, originates in Idaho and Eastern Oregon which are transported by barge down the Snake and Columbia Rivers to our Longview Mill. Sediment from the Cowlitz moves into the Columbia and then drifts into the inlet used by our raw material and energy barge traffic, posing a continuing threat to the operation of our mill. Since the mill employs approximately 2,000 people, a shutdown would have a significant negative impact on the local economy, and also on 12 other Company converting plants located across the country. These plants, which employ an additional 1,100 people, primarily depend upon the Longview Mill's products as their raw material. We request the permanent solution to controlling rivers' sedimentation be implemented as soon as possible.

We suggest that in the final decision on any local cost-share, the area's very slow recovery from the deep recession with continued unemployment ranging up to half-again the national average be considered. We believe this project should be fully-funded by the Federal government for these reasons:

* Nearly all of the problem sedimentation originates on Federal land in the National Volcanic Monument.
* The rivers' sedimentation threat reaches far beyond the local area with potential regional and national impact. Blockage of the vital Columbia River navigational channel servicing the Snake and Columbia Rivers Basins, or disruption of Interstate Highway 5 and the major North-South rail line, would have an enormous negative economic impact regionally and perhaps nationally.
* Traditionally, similar disaster recovery projects have received full Federal funding.

We greatly appreciate the Corps of Engineers' fine assistance to this area in the Mount St. Helens aftermath. Congratulations on your excellent and quick work constructing the permanent outlet for Spirit Lake -- we look forward to a quick permanent solution to rivers' sedimentation.

Curt R. Copenhagen
Director of Public Affairs
Longview Fibre Company

737

Greg Drew
5222 Spirit Lake Hwy.
Toutle, Wash. 98649
November 29, 1984

U.S. Army Corps Of Engineers
Portland District
Portland, Oregon

Dear Sirs:

My name is Greg Drew. I am a member of the Toutle Valley Preservation Association, and President of the Mt. St. Helens Chamber of Commerce. I would first like to dispel a rumor that Toutle area residents are the only people who oppose a dam structure. I first read this insinuating rumor in the Daily News. I would welcome a response if any one knows where the rumpr originated, or why the Daily News printed it, because it is not true. We have talked to citizens and organizations all along the Toutle, Cowlitz, and Columbia Rivers, and there are hundreds of people who oppose the dam.

It bothers me that there are people within the Corps of Engineers who are making assumptions about the Toutle River, but who had never heard of this river until the 1980 eruption. The Corps argues that the river is not yet armoring itself because there are not three - foot boulders lining its banks. They say it is unstable - that it meanders, cuts new channels, and moves sand deposits from one area to another. What they have failed to realize is that they are describing a phenomenon that has taken place on this river for generations. I am 34 years old. 25 years ago, I began swimming in the Toutle River. Every summer we had to search for a new swimming hole because the winter's high water had cut banks, changed course, moved log jams, and shifted sand bars. I also remember the upper stretches of river. Near Spirit Lake, the river was lined with large rocks and boulders. After only a few miles, this gave way to a meandering channel lined only with sand bars, pebbles and rocks, most of which were less than one foot in diameter. One could never depend upon the course the river would take until it went under the Harry Morgan Park bridge at Toutle, and started down the canyon which was lined with solid rock walls. Heavy winter rains always brought high,thick, dirty water filled with debris.

It's too bad every one hasn't had the opportunity to see the upper stretches of river in the last year. In August, I had the opportunity to stand on the banks of Coldwater Creek. The creek is contained in a rocked channel, and was running crystal clear, as was Castle Creek, and the North Toutle. If one questions the extent of surface erosion, I am reminded again of that August day three months ago. Next to Coldwater Creek we saw the tracks left by a piece of machinery called a survival cat which made its last run on December, 1982, nearly two years ago. Many people do not realize that once the Spirit Lake outlet is re-routed through Coldwater, the river will by-pass the majority of the debris avalanche.

If there is ever another major mudflow, I would imagine the people living down-stream would rather deal with the mudflow alone, rather than the potential hazard of an additional 50,000 acre feet of water being carried with it.

The citizens of this area are now faced with another dilema. First, the Corps is planning a multi - million dollar structure which many feel is not the best solution, and now, we may be forced to pay for a large portion of its funding. This is wrong. The eruption was a national disaster; it is located on federal land; it affected numerous counties, and involved at least two states. Any programs involving this phenomenon should be 100% federally funded.

In closing, I would like to say that yes, I feel there must be some steps taken to assist the river in its recovery, and to protect those people living down-stream from it. But I do not feel a high retention dam built to block spawning beds and to flood 5,000 acres is the best solution. I would also encourage each and every one of you as concerned taxpayers to do your darndest in obtaining a permit to go up to the mountain. Don't just fly over the area - you can't get even a half-way decent perspective of the recovery which is taking place unless you land, and get out on the surface. Then, judge for yourself.

The above has been a copy of the presentation I gave at the public input meeting held in Longview, Washington on November 29, 1984. In addition, I wish to add some suggestions for helping to solve some of the problems related to sedimentation and recovery: The Mt. St. Helens dilema is supposed to be an emergency situation, and that should supercede asthetic requests from certain organizations. I would recommend the following things be done:

1. Clear the logs from Spirit Lake.
2. Find a suitable vegetation and plant the lower mudflow.
3. Use uper river areas as the 1st dredge disposal sites.
4. Protect banks in some areas.
5. Do channel work on several miles of river just above and below N-1 dam.

Very truly yours,

Greg Drew

Greg Drew

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE ✓

WRITE OR CALL

Do you wish to remain on our mailing list? Yes (✓) No ( )

Do we have your correct mailing address? Yes (✓) No ( )

P.O. Box 26 4756 Spirit Lake Hwy

Why a dam? They Built Toutle, Wash. 98649
one & didn't keep it cleaned
out so it broke. Then you tell everyone
that it was supposed to do that. In
my book it sounds like you
people just want to ruin all
Homestead Owners land.
I hope some day if you own
any Homestead Land, It gets ruined
just like you want to do to ours.
Not only do you want the Dam, you
also want to widen the Spirit Lake
Hy up to the Volcano, why just
to ruin more Property. It moved
back off the Spirit Lake Hy. now
You're bring it back to my house
so they can speed more up to
the Dam. If you want a dam
Put it back where it was, above
Camp Baker, or no Dam at all.
No Dam! No Dam! No Dam!

Gail Todd
4756 Spirit Lake Hy
Toutle, Wash 98649

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

---

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE ✓

WRITE OR CALL

Do you wish to remain on our mailing list? Yes ( ) No ( )

Do we have your correct mailing address? Yes (X) No ( )

A high dam on the Toutle River will solve only part of the problem of sediment washing down into the Cowlitz and Columbia rivers. It would hold back a certain amount of sediment to be sure, and help solve the problem in the upper Toutle River.

Sediment behind any dam should be cleaned out in the deeper parts, once a year, making room for more to settle there in the future.

A number of smaller dams along the rivers would catch more sediment as the banks along these rivers are piled high now and continually erode filling up the river bed the whole length.

It would help also if stumps, logs and all trash could be cleaned out along the flow of the rivers. Sediment builds up and makes a place for more trash to build up with the current and puts a strain on the river banks until they in turn erode.

Cost sharing for the proposed flood control in the area of the Toutle and Cowlitz rivers, sounds reasonable until more thought is given to the property owners who are out of work and are now about to lose their homes because they cannot pay the present tax. Unemployment is high in this area.

When I pay my income tax I feel I must be paying a share already. Just too much money be going for things less important. We in this area think flood control is very important (NOW)!

Mrs. Mabel Stewart Longview, Wa.

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

We the undersigned oppose the construction of a dam on the Toutle River, it is not necessary, all sediment can be removed by dredging.

NAME	ADDRESS
Joseph M Gallad	153 Estes Rd Castle Rock Washington 98611
Terry L Herndon	186 Fish Pond Rd Kelso wash 98626
Gary L. Roggenback	120 Gilmore Rd. Toutle, WA 98649
Brian S. Greenwood	1625 Dorothy Ave. Longview, Wa. 98632
Patrick H. Schmitt	618 Studebaker RD. Castle Rock Wash. 98611

We the undersigned oppose the construction of a dam on the Toutle River, it is not necessary, all sediment can be removed by dredging.

NAME	ADDRESS
* Alen Wilkie	709 Riverview Dr. Castle Rock, Wa.
* [illegible]	1314 21st #12 LONGVIEW WA.
Benny L. Hill	800 N. 6TH KELSO
CR (Rolly) Riff	2406 Burcham "
* Hank [illegible]	4126 Rosewood Street, Lv. WA.
* Kathy Hammer	3303 Tori Lane, Longview
Gary L. [illegible]	917 Cedar # 14 Kelso
James a Nunn	132 ALPHA DR LONGVIEW
* John M Skean	3103 Hawthorn Longview
* Donald L Binion	P.O. Box 735 Kelso

* denotes floodplain residents

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream drødging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Douglas H. Noakes

Douglas G. Noakes

503 16th Avenue
Longview, Wa 98632

Dec 11 1984

Col. Robert Friedenwald:

Dear Sir.

In no way am I in favor of having a dam in the Toutle River I know you have heard lots of pro and cons. You know them all. The river is cleaning it self and has done so many time in the past and if left alone will do so again.

Please leave it alone!

Roy M Hollister
Box 294
Castle Rock wa
98611

December 10, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald:

I, as a concerned citizen am writing in hopes of pushing along your concept of a single dam to control the sediment problems in the Toutle River valley area and along the lower Cowlitz river, howerver I feel that since thiswas and is a problem on Federal land, that there is where the financing should come from.

We have friends and neighbors lining in an area where they are having to pay in excess of $4.00 per thousand in assessment alone on an outstanding debt for the raising of dikes, and for some this means they may have to sell or even lose there homes in some cases, now the added burden of having to pay for the acquition of land, the building of a dam will put the final period to there problem.

As for myself, I have had to discontinue my flood Insurance because of the excessive costs, I can NOT afford another expense.

A Long time resident of this community,

[illegible]

Mary R. Springer

[illegible]

[illegible] 98632

Robert N. Vaught
2408 34th Avenue
Longview, WA 98632

December 11, 1984

District Engineer
U.S. Army Engineer District,
Portland
Attn: NPPPL-AP
P.O. Box 2946
Portland, Oregon 97208

Dear Sir:

I wish to express my support for the preferred plan, single retention structure.

I hope that the processing of this proposed project can be done in an expeditious manner.

Sincerely yours,

Robert N Vaught

561 - 24th Avenue
Longview, Washington
December 12, 1984

Col. Robert Friedenwald, District Engineer
Army Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Col. Friedenwald:

We are writing to you in fervent support of the dam to control the sediment coming down from Mt. St. Helens. We can't help but be so concerned when we see the sand bars building up in the Cowlitz River and realize how the river is filling up with sediment.

We have lived in this valley for most of our lives and are now in our seventies, with our fiftieth anniversary next year. We do not believe we would lose our lives should a flood occur, and we could survive the loss of our home and furniture—after all, those are just material possessions. But what we could never replace would be the keepsakes of a lifetime—precious pictures of our children and a son who died in the service of his country, genealogies and pictures of our ancestors, scrapbooks, and the like. It would be a hurt that would never heal.

So we ask you to please use your utmost influence to support this dam. We who live in this valley would sleep much better at night if it were built.

Thank you!

Sincerely yours,

John and Hazel Erickson

John and Hazel Erickson

P.S. High priced flood insurance also keeps draining our retirement resources.

Teresa Bombardier
2408 34th Avenue
Longview, WA 98632

December 11, 1984

District Engineer
U.S. Army Engineer District,
Portland
Attn: NPPPL-AP
P.O. Box 2946
Portland, Oregon 97208

Dear Sir:

I support the preferred plan, a 177-foot structure at the Green River site, downstream dredging and some levee reinforcement, because it provides the greatest benefits for the lowest cost.

Also, I would request that this project be funded within the next two years.

Sincerely yours,

Teresa Bombardier

December 13, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

RE: Mount St. Helens

Dear Colonel Friedenwald:

This is in response to the Mount St. Helens Feasibility Report recently completed by the Corps. Please include this letter in the public hearing record. I have the following comments:

1. First, the Corps should be complimented on the excellent and thorough work done on the report. Our community appreciates the hard work done by your staff.

2. The Corps should take action as soon as possible to construct the 177-foot sediment control structure as well as other measures in the preferred plan. The longer action is delayed, the greater is the likelihood we will suffer major damages from a big storm event, a combination of storm events, or a mudflow. Statistically, it is only a matter of time.

   This area has lived through over four years of stress and anxiety regarding Mount St. Helens. It is also reflected in this area's high unemployment rates and development stagnation. Who would invest in an area with such uncertainty?

3. The federal government should fund the total project cost as it has in the past for cataclysmic natural disasters. Our local governments have already expended over $3 million. This project differs a great deal from "pork barrel" water projects where local cost share is most appropriate. Moreover, this disaster originated on federal land, and the protection to be afforded by this project benefits the region and nation by securing major interstate shipping and transportation facilities.

Thank you for this opportunity to comment.

Sincerely yours,

W.K. Lacey

W.K. Lacey
P.O. Box 106
Kalama, Washington 98625

December 14, 1984

District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Sirs:

I have followed closely the many issues regarding Mount St. Helens and especially the flood threat problems faced by Cowlitz River communities. Before December, 1982, my family lived in the North Kelso area. I witnessed the mudflows of May 18, 1980, and all the subsequent river dredging and levee building.

Even though the new levees were considered to provide good flood protection, there were many times when I felt high levels of anguish over whether or not storm events would cause flooding. My most prevalent feeling was of not knowing what the river siltation problem could be causing to happen next. Now we live on a hill well above flood hazards; however, I can still clearly understand the feelings of those residents along the river as this problem continues.

Therefore, I urge the Corps to as quickly as possible select a final solution to the flood hazard problems and get started on implementation.

With respect to my preference on alternative solutions I support the concept of keeping the debris in the Toutle Valley by building a dam, if necessary. The Toutle Valley has already been destroyed and allowing the debris to wash downstream to the Columbia River would only result in more losses as valuable wetlands are filled with dredge spoils. Columbia River losses may even include the estuary tide lands which could become silted with Mount St. Helens debris.

Sincerely,

Jim Fletcher

Jim Fletcher
108 Barbie Lane
Longview, WA 98632

55-487 0 - 86 - 25

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE ✔

WRITE or CALL

Do you wish to remain on our mailing list? Yes ( ) No ( )

Do we have your correct mailing address? Yes ( ) No ( )

TO WHOM IT MAY CONCERN.

I for one believe you should hold up on building a dam on the Toutle for a few years. Also would you also inform the local people how stable that [illegible] dam is.

I believe one thing you could do to save a lot of money would be to ~~[illegible]~~ eliminate [illegible] land at Pleasant Hill and save [illegible] the dredging it out below at the mouth of the river and also have a place to put quite a few million yards of sand.

One other thing that would help would be to riprap some of the Toutle to keep it in some sort of a channel instead of wandering all over the valley. Also patch the sand that has been dredged from the river so you won't ~~have~~ have to dredge it again.

Thank you

[illegible]

1313 - 22 [illegible] Ave

Longview Washington

98632

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

Dec 15 - 1984
501 Cline Rd
Castle Rock Wa

To Whom It May Concern

I'm writing in regard to the proposed Dam on the Toutle. We feel down stream from the Lake, the Toutle is establishing a permanent Channel - vegetation on the banks - fish returning - building & recovering - We do not believe this dam should be built - spending money to buy out huge land owners as Weyerhaeuser - We are grateful for the pumping station & the tunnel that were very necessary. But no dam -

Sincerely

Mr and Mrs [illegible]

746

We the undersigned oppose the construction of a dam on the Toutle River, it is not necessary, all sediment can be removed by dredging.

Name	Address
[signature]	114 Sierra Dr Kelso
Sally Harper	114 Sierra Dr. Kelso
[signature] Black	1108 4th Castle Rock
[signature]	4915 Pleasant hill Rd. Kelso
Elaine [signature]	4915 Pleasant Hill Rd Kelso

Longview Wash.
December,14,1984.

Colonel Robert Friedenwald:

Dear Sir:

Along with a lot of other people here in Longview and Kelso, I urge immediate action by the Corp,for the construction of the sediment control dam at the Green river site.

Because the disaster occurred on Federal land,we feel that no more funding be required. After all, the solution does have regional and national benefits.

Thank you for anything you can do to get the project going.

I am pleased at the progress with the tunnel project.

O.G.WOOLDRIDGE. * local funding.

O. G. Wooldridge

32 - 98 - 0 187-32

P.O. Box 694
Longview, Wa. 98632
Dec. 14, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Ore. 97208

Dear Sir:

In regard to the construction of the sediment control structures at the Green River site, I hope this project will receive your immediate action. Because of the unique disaster caused by the eruption of Mt. St. Helen's, I feel no more local funding should be required.

Also, due to the heavy snowpack in the mountains, which is comparable to the snowpack of 1948 at this early date, another Vanport flood disaster which occurred in the spring of 1948, could be a very real possibility in the Spring of 1985 in this area.

Thank you for your concern and serious consideration of the flood problems of this area affected by the Mt. St. Helen's eruption.

Respectfully yours,
M. Studeman

501 - 21st Ave.
Longview, Wa. 98632
December 15, 1984

Colonel Robert Friedenwald,

We are writing to you out of concern of Mt. St. Helens and the possible effects it could have in this community.

We would like you to very strongly support immediate Corps action to construct the sediment control structure at the Green River site. Also we feel there should be no more local funding required.

Mt. St. Helens was a unique disaster that occurred on Federal land. It is unfair to put more financial burden on our local community for a solution having regional and national benefits.

Again we strongly urge your support on this matter. We hope we can count on your support and thank you for your consideration to our very concerned plea.

Sincerely,
Harvey & Kathleen Clifton

12 December 1984

Dear Colonel Finkenwald

As a concerned citizen of Cowlitz County, I understand the Federal Government is trying to put it to us one more time.

I am <u>not</u> in favor of local funding for the construction of the sediment structures; but recommend the Federal Government take care of their property which caused the problem. The federal government wastes good money on buying expensive parts for the military; waste money shuttling Congressmen & Senators out of Andrews Air Force Base, etc. Do not use local funds.

I also support immediate action on the Corps' preferred plan of the sediment control structure at Green River, downstream dredging and levee reinforcement.

With all of these actions taken, maybe my flood insurance will

2

get down from 205 plus dollars to the original $45.

Thanks for listening!

Stephen W. Hayes

Dear Sir,

It was called to my attention how important it would be to write you a letter concerning the Green River site.

My husband and I have lived in the area for almost eleven years now. What used to be a booming place seems to be slowly dying due to many things. Mount St. Helens, economy etc.

We believe due to economic circumstances this is a problem. Many people have their homes for sale and are trying to get out of the area.

We do not believe the financial burden should be placed on a local community level.

We support immediate Corps action to construct sediment control structure at the Green River site;

Mount St. Helens was a unique disaster that occurred on federal land and should be supported financially by the federal government funds.

Thank you,

Richard and Joan O'Neill

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream drødging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Linine F. Randolph

2550 Lane Ave
Longview, Wa 98632

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream drødging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Frank J. Sarysz

4123 Pleasant Hill Road
Kelso, Wa 98626

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream dredging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Bernice L. Mackey

Bernice L. Mackey
329 Williams Road
Kelso, Wa 98626

Ray Ryan
243 Cook Ferry Road
Castle Rock, WA 98611

December 17, 1984

Colonel Robert Friedenwald
District Engineer
U.S. Army Corps of Engineers
PO Box 2946
Portland, OR 97208

Dear Colonel Friedenwald:

I wish to register my support for immediate construction of the proposed sediment control dam at the Green River site on the Toutle. It is imperative that this action be taken without delay and be supplemented with dredging of the Cowlitz River from Castle Rock to it's confluence with the Columbia River. There simply are not enough dredge spoil sites available upon which to place spoils at the current rate of flow into the Cowlitz. The consequences of inaction will be far more costly than the dam.

I am concerned however, that this project may be delayed by controversy over the issue of local funding. This county has been and is continuing to "Pay The Price" for the eruption of Mt. St. Helens. This has not been an experience that we wished upon ourselves anymore than one would a tornado, hurricane, or earthquake. We have already "Paid Our Share" in local costs and human suffering, yet there appears to be increasing pressure to add to our burden by requiring local cost sharing for the dam. We HAVE born the costs within our means and I ask this be considered before anymore burdens be placed upon our already depressed economy. This country has always SELF INSURED against disasters and we have not objected over the years to tax dollars being expended for Mississippi floods, or mid-west hurricanes. I, therefore, expect past policies to be continued.

One must remember that this is not a dam PROJECT, but disaster aid we are discussing.

Sincerely,

Ray Ryan

Ray Ryan

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream dredging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Michele V. Bogdon

Michele V. Bogdon

#6 Independence Court
Longview, WA 98632

December 16, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Friedenwald:

The purpose of this letter is in support of the Cowlitz County Community Consensus Position #2 for long-term Mount St. Helen's recovery.

Briefly, that letter supports immediate action on the Corp's preferred plan, construction of the sediment control structure at the Green River site, downstream dredging, and levee reinforcement.

I support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occured on federal land. It is unfair to put more of the financial burden on our local community for a solution having regional and national benefits.

Respectfully Submitted,

Robin Schwalm

Robin Schwalm

801 North 4th Ave
Kelso, Wa 98626

Col Friedenwald

There are many reasons I oppose a dam on the Toutle River.

① Why not clean the sediment out of the dam you have already built & it could be used

② There is no danger of flooding as the Cowlitz has never gone over the May 18 1980 level plus now we have 20' more elevation on the dikes.

③ The sediment is a problem however the North fork of the Toutle will slowly clense itself as the South Fork has -- remember when it was imperitive that a dam be built there. Dredging contracts could be issued to contain the amount of sediment

④ High dams kill fish, having caught many salmon on the Toutle; maybe people will again be able to do the same.

⑤ The pipe from Spirit Lake will put the water where there will be less sediment washed downstream

Jack Stauffer
114 Sierra Dr.
Lexington (Kelso)
I live in the lowest place in the area

December 11, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers

RE: Sediment control structure at the Green River Site

Dear Colonel Friedenwald

The purpose of this letter is to request immediate action by the corps for construction of a sediment control structure at the Green River site.

It is my opinion that Mt St. Helens continues to pose a threat to my family. I would hope that the federal government realizes that the St. Helens disaster occurred on federal land and that it would be unfair to put more financial burden on the community.

Thank you
William J. Wisc

December 17, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland Ore.

Bert Pale
3364 Olive Wy
Longview Wash.

Gentlemen:

I am writing on behalf of the Mount St. Helens sediment control structure.

I strongly support immediate construction of the sediment control structure at the Green River site, downstream dredging and levee reinforcement along with the requirement of no local funding. I feel that the solution should be handled nationally and not place additional financial burden on local residents.

Very truly yours

Bert L Pale

Colonel Robert Friedenwald — December 12, 1984
U.S. Army Corps of Engineers
Portland District
ATTN: NPPPL-AP
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel,

I'd like to express my support for the proposed 177 ft. sediment retention dam on the Toutle River at the Green River site. It is a sound permanent solution to the in-filling of the Toutle-Cowlitz-Columbia waterway that we currently face. Existing dredge disposal sites should be protected along with the dam project. It is the single most blatant and embarrassing issue that confronts those of us who support this solution. Most people in Toutle & those others opposed to a dam point to the already dredged spoils eroding in huge chunks back into the river as failures in Corps strategy & decision making process. I understand that early on projects were improperly funded for long-term maintenance, but with the benefit of several years on-site experience, its time these problems were addressed and put aside.

The general receptiveness to and credibility of the Corps and their proposals would be greatly enhanced if basic obvious violations of common sense were corrected, even at this late date.

I also think that too much baseless fear has been allowed to breed and circulate regarding the potential threat of the dam. I've attended most of the meetings held by the Corps at Toutle, Castle Rock, Kelso High, Beacon Hill and the Courthouse. Frequently the concern is expressed especially in Toutle and Castle Rock, that a dam on the Toutle would only add to the potential threat of a catastrophe. Analogies are constantly drawn between this sediment retention structure and the cracking or leaking water retention dams and reservoirs of California or elsewhere. It's my understanding that a minimum amount of water will be stored or reserved for settlement behind the dam and the more sediment deposited the stronger the structure becomes. Yet when the fear is expressed it usually comes when only public testimony is being given thus each concern goes unaddressed by the Corps. However, in between times the Corps could resolve these fears and mis-statements by speaking to the issue. Either it is or isn't a catastrophic risk.

Thanks for the opportunity to submit my opinion.

Sincerely

Don Manasco
101 Yelton Drive
Longview, Wash. 98632

712 Ostrander Rd.
Kelso, Wash. 98626
Dec. 12, 1984

Col. Robert Friedenwald,
Dis. Eng. Army Corps of Eng.
P.O. Box 2946
Portland, Ore. 97208

Sirs,

If the dam is the best and cheapest way to solve the Mt. St. Helens problem. I would want that.

Also I oppose a Corps recommendation that the local and state pay millions toward the dam. It's federal land so it should be paid for by the National government I think.

Thanking you

Mrs. Lillian Bundy

1010 8th Ave
Longview, Wash. 98632
Dec. 12, 1984

Col. Robert Friedenwald
District Engineer
Army Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Sir:

I'm writing to urge your consideration on a debris retaining dam to be constructed on the Toutle River.

The eruption of Mt. St. Helens has left the area with a continuing sediment problem. The potential for flooding is increasing.

We fear not only for our homes, our places of employment but also our own safety.

Please help us.

Respectfully
Patricia J. Nicholson
(Mrs. Dexter Nicholson)

December 11, 1984

Col. Robert Friedenwald
District Engineer
Army Corps of Engineers
P.O. Box 2946
Portland Oregon 97208

Dear Col. Friedenwald

An article in the Longview Daily News dated December 11, 1984 requested residents to write to you and urge construction of a 177 foot retaining dam on the Toutle River.

I am opposed to the construction of a dam because of the high cost and the fact that the Cowlitz river will still be filled with sediment.

I would favor dredging the Cowlitz river from the mouth to Castle Rock. I realize that finding close spill sites might be impossible but there are many sites within 10 miles of the Cowlitz River.

If a fleet of 10-12 yard dump trucks were used to haul the sediment many low lying areas could be filled and provide many commercial or residential building sites.

If the cost of each truck was $500.00 per day, 100 trucks would cost 50,000.00 per day or 250,000.00 per week. If you use a 50 week period the total trucking cost would only be 12,500,000.00

If you allot an additional 12,500,000.00 for dredging and sites the total cost would be less than 10% of the 292 Million cost for the dam.

I do not own any spill sites and I have no interest in trucks. My home is well above the flood plain but I do own rental properties in Longview and Kelso that might be flooded if the Cowlitz is not dredged.

I would think that a 25 Million package would be a lot easier to sell to Congress than the 292 Million package.

A reply stating that you have read this letter will be appreciated

Yours truly
W.A. Presnell
3007 Madrona Place
Longview Wa.
98632

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE WRITE OR CALL

Do you wish to remain on our mailing list? Yes (X) No ( )

Do we have your correct mailing address? Yes ( ) No (X)

My correct mailing address is: Mike & Joyce Coffey
2250 South 17th
Coos Bay, Oregon
97420

Without knowing what is possibly being considered as solutions, it is hard for us to make much of a comment.

We have faith in the Corps of Engineers to do a good job and appreciate a chance to voice our views. We look forward to seeing the results of the Detailed Study due to be finished in Sept. 1985.

Right now all we can comment on is that we consider the environmental aspects very, very important!! If these aspects are considered thoroughly at the very beginning, then there should be no problems at the finish!!

Michael & Joyce Coffey

Please fold this sheet and tape or staple the edge. — NO POSTAGE REQUIRED —

To Mr Jon D. Katin
Lieutenant Colonel, CE
Acting District Engineer

From: Zoltan Kuse
111 Front St
Longview. Wa. 98632
11 - 10 - 1984

Re: Mt. St. Helens, Washington Feasibility Report.
a Draft Environmental Impact Statement.

Dear Lieutenant Colonel Katin.

Thank you for this opportunity to comment on the above said Environmental Impact Statement.

Being a residence of Cowlitz Co. for the past 20 years, We will be affected (including my family also) with the outcome of this proposed projects.

We are preferring the Single Retention Structure alternative to be built at the Green River Site, approx. RM 13.5 on the North Fork Toutle River. We would like to see, that the structure will be designed and the foundation is constructed so that the structure itself could be built upto 202' Hight if needed, than use stage construction technique to accomplish objectives. Refer to Page VI-6, Table VI- 2 item (3).

We prefer this alternative because of the unknown amount of loose material, which is out there, but nobody really knows at this time, that how much of that material is going to move downstream.

Sincerely
Zoltan Kuse

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE WRITE OR CALL

Do you wish to remain on our mailing list? Yes (✓) No ( )

Do we have your correct mailing address? Yes (✓) No ( )

Dec 14, 1984

Alan W. Godfrey
150 Godfrey Rd.
Kelso, Wa 98626

Dear Sir,

I attended the meeting in Longview on the Silt Retaining Structure on the Toutle River.

I've lived hear virtual all my life of 45 years. The Toutle was one of my favorite recreational areas. I don't like to see this happen means the S.R.S. But I feel it will be for the good of the Area down stream to control the silt flow into the water ways, ~~to~~

Where I live is on the old Kelso mudflow at 100 ft elevation at one time the level was approximately 175' ele. It seems to be quite stable now.

But looking at the rivers as long as silt runs the channels change. like down stream at Puget Island. I figure This is caused by silt flow from Mt. St. Helens.

The SRS. is not only important to the County of Cowlitz but to the State of Washington & Oregon along the rest of the Country. Also to the world.

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE WRITE OR CALL

Do you wish to remain on our mailing list? Yes ( ) No ( )

Do we have your correct mailing address? Yes ( ) No ( )

I know with The depress condition of this area. We the Tax payers can not even share in the cost of the SRS on a county or a State level.

I think this should be funded on a strict Federal level. So that every one can enjoy the cost of a natural disaster that we've lived with for the past 4½ years.

The SRS. should be built of good solid material also kept ~~to~~ with in the natural beauty of the area as much as possible. If it isn't built solid we must remember the "Teton disaster"

What about future plan for a hydroelectric project using flumes to transfer the water to generators?

I've hope to live here many more years. Some of my Sons are also living here.

And again I do stress the importance of total Federal Funding for this project. because of the importants to the country as a whole.

Also. Do it As Soon As Possible.

Thank you

Alan Godfrey

150 Godfrey
Kelso, Wa 98626

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

12/15/80

Col. Robert Friedenwald
District Engineer
Army Corps of Engineers
P.O. Box 2946
Portland, Ore 97208

Dear Sir:

My wife and I urgently support quick construction of the proposed 177 foot tall retention dam on the Toutle river to lessen possible flooding downriver in Longview where we live.

We also oppose the Corps recommendation that local and state governments contribute up to $17 million toward the costs of such a dam.

Sincerely
Mr and Mrs Lee W. [illegible]
2829 Fir
Longview, Wa. 98632

WE WOULD APPRECIATE YOUR COMMENTS

PLEASE WRITE OR CALL

Do you wish to remain on our mailing list? Yes (✓) No ( )

Do we have your correct mailing address? Yes (✓) No ( )

Speaking as a layman and resident citizen, my continuing concerns are:

#1. The delay in implementation of a majority consensus solution, namely the single retention dam with appropriate dredging.

#2. The economic effects that continue to accumulate and aggravate with the uncertainty of implementation of this viable solution.

#3. Volcanic eruptions on federal land are not a common occurrence in the U.S.A. therefore we are not being provincial in our expectations of relief.

#4. Your in depth procedural efforts have been lucid and valid but the legend of "Damocles" will continue to disturb the man on the street:

"How much longer will the thread hold?"

Sincerely,
Karl Jonasson

KARL G. JONASSON
812 S. 3RD
KELSO, WASH.
98626

Please fold this sheet and tape or staple the edge. -- NO POSTAGE REQUIRED --

12/14/84

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald,

I am asking you to support the construction of a sediment control structure at the Green River site. I have lived in Longview for 38 years and have never seen the Cowlitz so choked with sediment that one could walk three fourths of the way across on sediment. This was easy to do this summer.

I would thus seek to enlist your support for immediate corps action to construct the sediment control structure on the Green River site and to do this without the help of local funding. It is unfair for us to pay for a disaster that occurred on federal land.

I personally have paid better than a thousand dollars just for flood insurance in the last 4 years.

Thank you for your cooperation.

Sincerely,

Lee Culkin
297 16th
Longview, WA.
98632

Dec. 17, 84

Mr. Friedenwald,

I am writing to you as a concerned citizen of the Longview area over the issue of sediment Control at the Green River site.

I do support the belief that an immediate Corps action to construct a sediment control structure at the Green River site is a necessity—Now—and that no more local funding should be necessary or required. It is highly unfair to put more financial burden on our local community for a solution having regional and national benefits.

Thank you kindly for your cooperation in this matter.

Sincerely,

Carolyn Shelton

Dec 13, 1984

Dear Sir;

I am a Tax paying Home-owner Residing in Longview Wash I urge you to Start the Debris Dam on the Toutle River I feel if this is not done, the Silt will clog Cowlitz + Columbia River at the port of Longview Stopping Ship traffic to Longview, Kalama, + Portland Ore. Causing untold Revenue.

This Community has and is now Suffering in many ways Construction is way down, houses are not Selling Causing Economic hardships to all. the Federal Flood Ins. has tripled and more, so that many of us, including me Cannot afford the premiums

I also believe the proposal to has Cowlitz County Residents to Levy 17 million dollars is too much + will Raise Taxes to the point we cannot pay them + Lose everything we have.

I Respectfully ask you Consider this request because it surely is Valid.

Respectfully,

Arnold R Olson

333 - 18th

Longview Wash

98632

Mrs. V. K. Harvey
686 25th Ave.
Longview, Wash. 98632

District Engineer
U.S. Army Engineers
Portland District
Attn. NPPPL-AP
P.O. Box 2946,
Portland, OR 97208

Gentlemen:

Construction of a retention dam on the Toutle River must be accomplished to protect the cities downriver.

To saddle the cost of this dam on the residents of these cities would be almost as disastrous for them as a mud-flood. Many of us on fixed pension incomes can no longer even afford flood insurance. Nor can the many who are out of work.

We do pay federal taxes and the cause of all this is on federal land. Therefore, that should be the source of payment.

Very truly yours
Penelope V. Harvey

---

500 Church
Kelso, Wa. 98626
Dec 11, 84

Col. Robert Friedenwald
Dist. Engineer.
Army Corps of Engineers:
P.O. Box 2946,
Portland, Oregon 97208

Dear Sir;

We live in Kelso, Wa. near the Cowlitz River, and have had many worries and problems since Mt. St Helens Blew up & filled our river with silt.

We are very much in favor of the quick construction of the 177 ft dam on the Toutle River.

I'm sure it would be much better judgement to build the Dam, then pay to dredge both the Cowlitz & Columbia rivers for years to come. We need the dam for our protection.

Sincerely
Mr + Mrs A.W. Mott
500 Church, Kelso, Wa 98626

766

Dec. 11, 1984

Col. Robert Friedenwall; District Engineer
Army Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Sir:

I hope you understand this community is vitaly concerned with the construction of the 177 foot tall debris-retaining dam on the Toutle River and request you to proceed in any way necessary to obtain the congressional funding.

It should be made clear since Mt. St. Helens is on federal lands. It is unfair to put additional financial burdan on the local community for regional and national benefits.

Sincerely
Mrs. Elaine E. Bradford
2024 Tibbetts Dr. #99
Longview, Wa 98632

Dec. 12, 1984

Col. Robert Freidenwald:

I would like to express my views on the proposed retention dam on the north Toutle River.

I am a retired land surveyor and timber cruiser, and worked on most of the Toutle River after the eruption in 1980 and 1981 cruisind heat killed trees for the Weyerhaeuser Co. and other land owners, including areas well above the proposed location of the retention dam.

I found miles of the river valley filled with soft sand, pumice, etc. in places ¼ mile wide and 12' to 16' deep, a pickup would sink out of sight, and no rock armoured banks, as some are reporting.

I do not attempt to estimate the million yards of sedimate that will eventually ~~contri~~ wash in to the Cowlitz in the next 25 or more years, as the Corps is well qualified to do this, however my view is that the retention dam is needed.

Most of the opposition comes from residents of Toutle, who would not be affected by flooding of the Cowlitz valley, or lose property acquired under the 'eminent domanin' law, as residents in the Cowlitz River valley are.

Alden Jones is showing slides taken in summer when pumps were shut down, this is not a true picture of the danger. The same area he shows as a trickle of water in summer can be a raging flood, uprooting trees 4 feet in diameter in dense storms.

Respectfully Gordon Kerr

Longview, Wash.
Dec 15th

Col. Robert Friedenwald
District Engineer
Army Corp of Engineers
Portland, Oregon.

Dear Sir;

Please construct a Dam on the Toutle River at the earliest possible time. Also I'm opposed to the Corps recommendation that State and local Governments pay 6% of the total costs of the dam.

Thank you,
Yours Sincerely,
Lois Hartwell

Dec. 12 '84

Sir

Being residents of the lowlands we are urging the quick construction of the dam on the Toutle River. Many of the citizens of Cowlitz County have had to let our flood insurance lapse because of the continuing expense. Also in regards to the recommendation that we assume 4% of the total cost, please remember that our local unemployment is well above the national level.

Sincerely
Mr. Mrs L. S. Perre

12-8-84

Dear Colonel Frieden WALD,

We are in support of immediate Action on the Construction of the Sediment Dam on the Toutle River, At the Green River site. We also need Levee reinforcement and Downstream dredging.

We do not feel Local Funding for this project is fair, As this community has had an unfair financial Burden put on it Already because of the MT. ST. HELENS Disaster.

Sincerely,

G. A. Rolfe Sr.

Grace A. Rolfe

Dear Sirs.

Please build the dam soon - we really need it so very much.

We've been under the cloud for too long.

God bless you

Shirley G Dalsgard

December 14, 1984

Col. Robert Friedenwald
District Engineer
Army Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208

Dear Sir:

A high dam to ratain debris from flowing down the Toutle River needs to be built immediately and the federal government should finance this dam. It is urgent that it be started as soon as possible and be completed with dispatch.

Cowlitz county has not seen the recovery that is in evidence for much of our country. The volcano which caused the debris which will be washed down onto our communities with unusually high rainfall or some unforeseen cataclysm is no fault of the residents of Cowlitz county; it is an act of God and our nation should see that no more disaster strikes our residents than can be helped.

Respectfully,

Roland A. Lyons
Morita A. Lyons
3203 Lindsey Drive
Longview, Washington
98632

Dist. Engineer 12-12-84
Army Corp of Engineers
P. O. Box 2946
Portland. Ore

RE: Dam on Toutle

Dear Colonel Friedenwald,

This is a request to please get the dam built on the Toutle River to protect the Toutle drainage system.

We lost our home & all of our possessions during the Volcano. We're fine now but why should others have to live in fear?

Something has to be done so please do the best that's available at this time.

Thank You.

Mrs Janet Fricke
2353 Tower Rd
Castle Rock Wa 98611

Dec. 14, 1984

Corps of Engineers
Attn: Col. Friedenwald

I am writing in support of the construction of the sediment control structure at the Green River site. We are still not "resting easy" here in Kelso, & want to be heard again when the funding decisions are made (& before the big federal cuts hit us!)

We need help! Local funding alone cannot begin to do the job!

Sincerely,
Mrs. E. H. Peterson

2655 Maple Street
Longview Wa 98632
December 14, 1982

Col. Robert Friedenwald, Dist. Eng.
Corps of Engineers
P.O. Box 2946
Portland, Or. 97208

Dear Sir:

Please take immediate action to construct a sediment control structure at the Green River site to prevent flooding of the area below. You are well aware of the lives and valuable property at stake.

Since Mt St. Helens was a unique disaster and occurred on Federal land, further local funding should not be required. It is certainly unfair to put further financial burden on this community for a solution having regional and national benefits.

Respectfully,
Margaret B. Gudgel

IIIO N. Third Ave.

Kelso, Washington 98626

Dec. I5, I984

Colonel Robert Friedenwald

District Engineer, Corps of Engineers

P. O. Box 2946

Portland, Oregon 97208

Dear Sir:

I understand that this is the time when project funding decisions are being made. It has been over four years since the disasterous Mt. St. Helens eruption. I am writing to ask your support for immediate action on the construction of the sediment control structure at the Green River site and asking that no more local funding should be required.

Sincerely,

Mrs. A. J. Larsen

December 14, 1984

Col. Robert Friedenwald
District Engr
Corps of Engrs
P.O. Box 2946
Portland, Oregon 97208

Dear Col Friedenwald:

We totally support immediate action by the Corps of Engineers to construct the sediment control structure at the Green River Site and believe that we have had enough of a financial burden locally. We feel that Federal financial support is of the utmost importance at this time.

Very truly yours,

Mr. & Mrs. W. A. Kemper

505 Division
Kelso, Wash.
Dec. 14, 1984

Dear Colonel Friedenwald—

Every one I talk to believes that a sediment retaining structure should be built at the Green River site,— and stop dragging this issue from year to year. It is a terrible feeling to be worrying about this every winter.

If at all possible there shouldn't have to be anymore local funding — since it occurred on Federal land. and it would benefit the region, the shipping lanes, etc

Thank you

Sinerely,
Zelba Saffel

12-14-84
Longview

Dear Colonel
Robert Friedenwald

Just wanted to let you know my support for Corps plan to construct a sediment retaining structure at the green River site immediately.

I think that no more local funding should be required, because St. Helens eruption disaster occurred on federal land. It is unfair to put more financial burden on our local community for a solution having regional and national benefit.

This is also the time of deep federal budget cuts considered in Congress!

If we lack immediate action for Corps plan we must have chance to fund this project.

Sincerely & hopefully
G. Kaplin
2814 Lilac Longview

12-14-84

Colonel Robert Friedenwald
District Engineer, Corps of Engineers
P O Box 2946 Portland Or. 97208

Dear Sir:-

We support your immediate action to construct a sediment control structure at Green River site, as we have home in West Kelso & business in Longview.

We feel the mountain is still a danger but it should be payed for by the government, the disaster occurred on federal land.

We are senior citizens can't afford any more taxes

Thank you

Yours, truly
Frank & Hope Taylor
204-S-5th-W
Kelso Wash. 98626

1755 Arkansas St
Longview, Wa
December 14, 1984

Dear Robert Friedenwald, Colonel

We as Citizens of U.S.A and residents of City of Longview We are much Concerned about Mount St. Helens.

My husband and I would like for the Corps action to Construct the Sediment Control structure at the Green River site, and that no more local funding should be required because this disaster occured on Federal land, and we feel the federal Government should start doing something about it soon. We feel it is very unfair to Put more financial burdens on our local Community. Do hope you Can do something. The old saying goes, "a stitch in time saves nine." Do hope you Can do something about this situation. Sincerely

Robert & Selma Bricknell

Longview-Wa.
12-14-84

Dear Col. Friedenwald:

Kelso & Longview are in danger of bad flooding in case the dike broke or other things happen.

There are two issues to be stressed. My support for immediate Corps action to construct the sediment control structure at the Green River site & that no more local funding should be required. Mt St Helen's was a unique disaster that occurred on federal land. It is unfair to put more financial burden on our local Community for a solution having regional & national benefits.

Sincerely
Daisy Turner
1614 - 9th ave
Longview. Wa.

Gentlemen.

We stress your immediate support for action to construct the sediment control structure at the Green River site —

and that no more local funding should be required. Mount St. Helens was a unique disaster that occurred on federal land. — It is unfair to put more financial burden on our local community for a solution having regional and national benefits —

Mabel Kent
Longview Wa.
98632

775

MRS. C. D. PEASE
3233 WILDWOOD DR.
LONGVIEW, WA. 98632

Dec. 14, 1984

Colonel Robt. Friedenwald
District Engineer
Corps of Engineers
Portland, OR.

Dear Colonel,

I am writing to urge the Corps to take quick action to construct the sediment control structure at the Green River site. We who live in this area feel as if we have a time bomb up there. If it goes off, our community could cease to exist. It would be great if we could finance it ourselves but no locality could do that. This was a disaster that occurred on federal land & the solution to the problem should be national.

Please do what you can.

Sincerely,

Mary L. Pease

---

135 Maddux Rd
Castle Rock, Wash 98611
December 13, 1984

Colonel Robt Friedenwald
Dist Engineer of Corps of Engineers
Box 2946
Portland, Ore 97208

Dear Sir,

We feel it is imperative that the sediment dam on the Toutle River be built as soon as possible!

Sincerely

Mr + Mrs C E Whittle

December 14, 1984

Col. Robert L. Friedenwald
U.S. Army Corp of Engineers
Attn: NPPPL-AP
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel Fiedenwald:

We wish to express our view of the solution regarding Mt. St. Helens and the problems created with it. Since May of 1980 we have lived with the potential hazards of flooding on the Toutle and Cowlitz Rivers. We have carried National Flood Insurance since May 1980, however due to the increase in cost (from $30.00 in 1980 to $193.00 in 1984) we are concerned if we will be able to afford it in the future. We know of many who are unable to afford it as the cost rises so fast.

We strongly support immediate action on the construction of the 177 ft. debris retaining dam on the Toutle River. We also feel that the Federal Government should finance the total cost of such a dam. Our local economy is poor and as this was a "disaster" we feel we local citizens should not have to take on further burdens.

We are watching this situation with extreme interest.

Sincerely,

Mrs. Jeffrey L Davis

Mr. & Mrs. Jeffrey L. Davis
4406 Constitution Lane
Longview, WA 98632

December 11, 1984

Col. Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Col. Friedenwald:

Cowlitz County has a unique problem, as you are well aware. The eruption of Mt. St. Helens on federal government land in May, 1980 has provided all residents downstream of the Toutle, Cowlitz and Columbia Rivers many sleepless or at least restless nights.

The Corps of Engineers has provided much help to these residents and it is greatly appreciated; but, now The Corps has the opportunity to provide permanent flood control measures to the downstream population. We urge you to take immediate action to construct the dam at the Green River Site with haste. This would decrease the need for all the dredging which has proven to be only a "stop gap" solution to the erosion of riverbanks and the need for levee reinforcements.

As residents of the Lexington Flood Control District, we must request the the federal government foot the bill for the land acquisition necessary for this construction, as well as for the cost of the dam proper. This flood control measure will have regional as wellsas national benefits through the protection of the Columbia River shipping lanes. The residents of the lower Cowlitz River valley already are strapped with the costs of heavy increases in flood insurance payments. In addition, the Lexington Flood control District is taxing its constituents $4.84/M to pay for the cost of rights-of-way and settlements due to the raising of our local levee.

We again implore you to assist us with the total federal funding of the Green River dam construction and land acquisition costs.

Respectfully,

Dick & Judy Ainslie

Mr. & Mrs R.A. Ainslie
105 Modesto Drive
Kelso, Washington 98626

Dec 13-1984

Sir -

Lets get on with a 177 ft. tall debris - retaining dam on Toutle river -
Would be an answer to saving many lives - which is more important than many ways money is being spent for -
I urge you to get on this at once.

Sincerely

Irene M. Hart

605 California way #5

Longview, Wa. 98632

12-14-'84

Col. Friedenwald,

Dear Sir.,

We are still very concerned about the silt from Mt. St. Helen's coming into the Cowlitz & Columbia Rivers which could cause a disastrous flood to all of us living near the rivers so we hope & pray that you will hurry the building of the dam on Toutle R. to prevent this from happening.

Thank you.

Yours truly,

Joe and Martha Merly

126 N. Maple

Kelso, Wa.

98626

Dec 13 1984
Kelso Wash

Colonel Robert Friedenwald.

Dear Sir:

I am so worried about the river flooding and don't know why we can't get someone to build the dam on the Green river, that people who live here in Kelso and Castle Rock, don't get flooded out.

This has been going on since the Mt. erupted and nothing has been done.

People who don't live here don't worry or care about us. With the dredging that has been done couldn't there have been a dam built?

There won't be any end to the silt or ash that comes down the Toutle's into the Cowlitz.

I am a widow and I worry about the rivers flooding and I am not the only one.

So I certainly hope that the dam can be built very soon so we can feel safe.

If you lived here wouldn't you worry.

Dorothy Grant
507 Colorado #13
Kelso. Wash 98626

December 13, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208

Dear Colonel Robert Friedenwald:

This letter is in support for immediate action on the Corps preferred plan, construction of the sediment control structure at the Green River site, downstream dredging, and levee reinforcement.

We also support the requirement of no local funding for the project. Mount St. Helens is a unique disaster which occurred on federal land and therefore the financial burden should not be borne by our local community. This area has suffered through four years of dealing with the stress of the Mount St. Helens problems - the threat of flooding, loss of property, loss of business developments, high unemployment - to name just a few. This area does not need the added burden of funding this project. The federal government should fund the total project cost as it has in the past for other major natural disasters.

Thank you.

Sincerely,

Jim & Kathy Mauck

Jim & Kathy Mauck
607 Cloverdale Road
Kalama, Washington 98625

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
PO Box 2946
Portland, OR 97208

12-13-84

Dear Colonel Friedenwald

As citizens of Cowlitz County Washington we are very concerned & tired of the continuing sediment problem created by Mt. St Helens. We support & encourage immediate action on the Corps of Engineers' preferred plan for the construction of the sediment control structure at the Green River site, downstream dredging & levee reinforcement.

We also support the requirement of no local funding for this project. Mount St Helens is a unique disaster which has affected more than Cowlitz County. It is unfair to put more of the financial burden on our local community for a solution that has regional & national benefits.

We are tired of worrying about the sediment problem and would like to see a solution as soon as possible.

Thank you

Sincerely

Nancy Boyd & Sam Boyd
106 Mecklenburg Dr, Kelso, WA

Longview, Washington
Dec. 15,1984

Colonel Robert Friedenwald
District. Engineer
Corps of Engineers
P O Box 2946
Portland, Oregon 97208

Dear Colonel Friedenwald,

I am asking for support for immediate Corps action to construct the sediment control structure at the Green River site-.

No more local funding should be required. It is unfair to put more financial burden on our local community for a solution having regional and national benefits.

Thank you for your help.

Sincerely,

Mrs. Helen Maier, Senior Citizen
271 20th
Longview, Washington 98632

---

829 Fall Cr Rd
Longview Wa 98632
Dec 15 1984

Dear Sir

I am taking a few minutes to offer my support for a sediment Retention dam on the toutle. as I believe it will save much dredging on the lower river.

I also support that this problem belies a need for federal funds as problem occurs on federal land. this area has suffered enough through high interest rates & the threat & continued plugging of our Water Ways into the future

Sincerely Yours
Frank Sedlacek

Kelso, Wash
Dec. 13, 1984

Col. Robert Friedenwald,
Dist. Engr. Corps of Engrs,
PO Box 2946
Portland, Oregon, 97208....

Dear Colonel Robert:

I am a member of the Mt. St. Helens Hiking Club, PO Box 843, Longview, Wash. 98632...We have about 100 members and go on record favoring:

1...Your immediate support for Corps action to construct the sediment control structure at the Green River site;

2...That No More local funding should be required........

Mt. St. Helens was a unique disaster that occurred on federal land...It is unfair to put more financial burden on our local community for a solution having regional and national benefits...

Sincerely,

Mr/Mrs Robert & Erma Fristad
1005 No 6th Ave,
Kelso, Wash... 98626
phone 206-423-7789....

Robert Fristad
Erma Fristad

2324 48th Ave.
Longview, Wa 98632
December 14, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P. O. Box 2946
Portland, OR 97208

Dear Sir:

As a concerned homeowner in the Longview area, part of the flood plain Of the Toutle and Cowlitz Rivers, I am asking your support for the following:

1. Immediate corps action to construct the sediment control structure on the Toutle at the Green River site.

2. The Mt. St. Helens disaster was unique and that no more local funding should be required. This disaster occured on federal lands and it is unfair to put more financial burden on our local community for a solution having regional and national benefits.

Thank you for your consideration in this matter:

Sincerely;

Carl H. Dunning
Carl H. Dunning

Dec. 10, 1984

Col. Robert Friedenwald
Army Corps of Engineers
P.O. Box 2946
Portland, Ore. 97208

Dear Sir:

We are taking this means to express our views of the solution to the Mt. St. Helens problem. For 4½ years now, we have lived with the potential hazards of flooding on the Toutle and Cowlitz Rivers. National Flood Insurance rates have increased so much that many home owners have dropped the coverage.

We strongly support immediate action on the construction of the 177 foot tall debris retaining dam on the Toutle River. Furthermore, we feel the federal government should finance the total cost of such a dam. Our local economy is poor and should not be expected to take on further burdens.

Sincerely,

Mr. & Mrs. Paul Gilpin
1135 - 9th Ave.
Longview, Wash 98632

December 15 1984

Colonel Robert Friedenwald
District Engineer, Corps of Engineers
P O Box 2946
Portland OR 97208

Please! We need your support for immediate Corps action to construct the sediment control structure at the Green River site. We in the Cowlitz River corridor live with the fear of flooding, if the huge sediment in the Toutle valley breaks loose.

Remember, Mount St Helens was a unique disaster that occurred on federal land and it is unfair to put such a financial burden of paying a large sum of money to help the project. We are still a depressed community on the economic scale, so would really appreciate all the help you can give us.

In advance, I and my family thank you very much.

Most Sincerely,

Mrs. Genevieve Mayo

Mrs Genevieve Mayo
1634 Minor Rd #2
Kelso WA 98626

Dec 12, 1984

Army Corp of Engineers:

We are writing to urge that the Corps begin work as soon as possible on the debris-retaining dam that has been proposed for the Toutle River. We would hope that after four years this constant threat and problem will be taken care of. If this is delayed, and a disaster happens, I'm sure the people in the St. Helens flood plain will not be as easy to explain to as the residents of India.

I would also urge that the Army Corps would see its way clear to pay the cost of this project, instead of laying part of the cost on the residents here who had no part in the eruption and who have already assumed considerable expense in the ongoing cleanup and protective measures.

Sincerely,

William & Esther M. King
2943 Field St.
Longview, Wa. 98632

783

Longview, Wash.
Dec 12, 1984.

District Engineer,

I am writing in regard to the Dam we need so badly on the Toutle River that affects a lot of towns here in Cowlitz County. Mt. St. Helens has caused so much damage to a lot of people I think the Government should do all they can to stop any further damage as soon as possible. We need action as fast as possible.

Sincerely,
Harriett McDaniel
365 18th St.
Longview, Wash.
98632

12-7-84

Dear Colonel Friedenwald,

I am supporting immediate action on the construction of the sediment control structure at the Green River site along with levee reinforcement and down stream dredging.

I am against local funding as I feel the problem originated on Federal land and the local community has had an unfair financial burden placed upon it.

Thank you.

Sincerely,
Donna R Rolfe

Dec. 12, 1984

Col. Robert Friedenwald
District Engineer
Army Corps of Engineers

Dear Col Friedenwald

We would like to see quick construction of the 177-foot tall debris-retaining dam on the Toutle River.

Thank you for your time.

Paula Bartlett
Bob Bartlett
1608 Holcomb Ave
Kelso, Wash 98626

Portland District
U.S. ARMY Corps of Engineers
ATTN NPPPL-AP
P.O. Box 3946
Portland, Oregon 97208

1530 N.E. 10th Ave.
Portland, Oregon 97232
Jan. 24, 1984

Dear colonel!

In responce to your communication relating to plans for a permadent solution to the sediment control problem on the Toutle, Cowlitz, and Columbia River

Bearing in mind the enormous problem you were faced with at the time uncontrolled sediment clogged the Columbia river to the extent that ships were unable to proceed to their destination, until the sediment was removed.

So, needless to say, your plan to create a permanent solution to eliminate that problem, especially considering that it is possible that further volcanic, unexpected activity on Mt. St Helens, could make the problem of a permanent removal of sediment more difficult yes,

I would appreciate having a copy of the material relating to to this project sent to my above address. Thank you

STANLEY G. HOOPER

Stanley G. Hooper

Ans 11/2 7/84 jd

115 Williams Ave.
Kelso - Wa 98626
Dec. 13, 1984

Dear Sir:

For four years we've waited for some action on a permanent solution to sediment in the Toutle & Cowlitz rivers from St. Helens. There have been briefings & studies and more studies and then more studies. In the meantime we keep buying expensive flood insurance every year and pray we won't need it for our home of 33 years.

Now more local funding is being asked for. How come the local taxpayers are asked to pay for a disaster that occurred on federal land?

If the powers that be had acted sooner instead of demanding one study after another. look at the money that would have been saved on making the studies plus the dredging every year.

It's finally been decided that the one dam is the best way to go. What are we waiting for now?

A Concerned homeowner
& Taxpayer

Ferne Vining
Ralph L. Vining

~~Longview~~ Wn
Dec, 16.84

Colonel Robert Friedenwald
Corps of Engineers
Portland Or.

Dear Sir.

We all hope the construction of a sediment structure on the Green River site will be done as soon as possible.

With out more funding by the people in this area. With so many people out of work its really been rough for so many.

Yours Truly
Muriel L. Gulickson
2245 - 40 th
Longview Wn
98632

787

Dec. 14, 1984

Colonel Robert Friedenwald:

You have our support for immediate Corps action to construct the sediment control structure at the Green River site.

Also please request that no more local funding be required. Mt. St. Helen's was a unique disaster that occured on federal land.

This has been a tremendous emotional + financial burden for our community. Let's get it resolved.

Thank You,
Doris DeShazo(?)
David A. DeShazo(?)

605 Peardale Lane #27
Longview, WA 98632

December 11, 1984

Colonel Robert Friedenwald
District Engineer
Corps of Engineers
P.O. Box 2946
Portland, OR 97208

RE: Mt. St. Helens Recovery Issues

Dear Colonel Friedenwald:

As a concerned citizen, I would like to offer the following comments. I believe the federal government should act in the most expeditious manner possible to alleviate the threat of continued problems from the Mt. St. Helens eruption.

The on-going damage to navigable waterways, local economic recovery and community stability can be alleviated if a long-term permanent solution is implemented quickly. It appears that the preferred plan proposed by the Corps is the best option for doing just that.

However, by requiring local and state governments to participate in funding this project, the very problems for which the project is needed will be adversely affected. Local economic recovery and community stability will not benefit by the imposition of a financial burden to the state and local governments.

A volcanic eruption is an unusual and rare disaster in this country. The necessary steps which must be taken to minimize the long-term negative impacts from this occurrence need to be seen as a one-time exceptional response. It would be appreciated if you would urge the federal government to offer assistance without further cost to the state and local governments. Thank you.

Sincerely yours,

Beverly Bright

Beverly Bright

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15 November 1984

Hey, I know this sounds like a goofball idea but, read this article about beavers, could it some how be implimented as "minor retention conservation.

Also, about the "plug" between the mountain and Harry's ridge are you going to fill that in with ~~[illegible]~~ rock to attack the erosion? and possible "wash-out"?

Thank - you
Malcolm Worrell

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